

PROGRAM
YOUR
HECKBOOK

FROM OUR ELECTRONICS NOTEBOOK - KEEPING UP WITH CAPACITORS

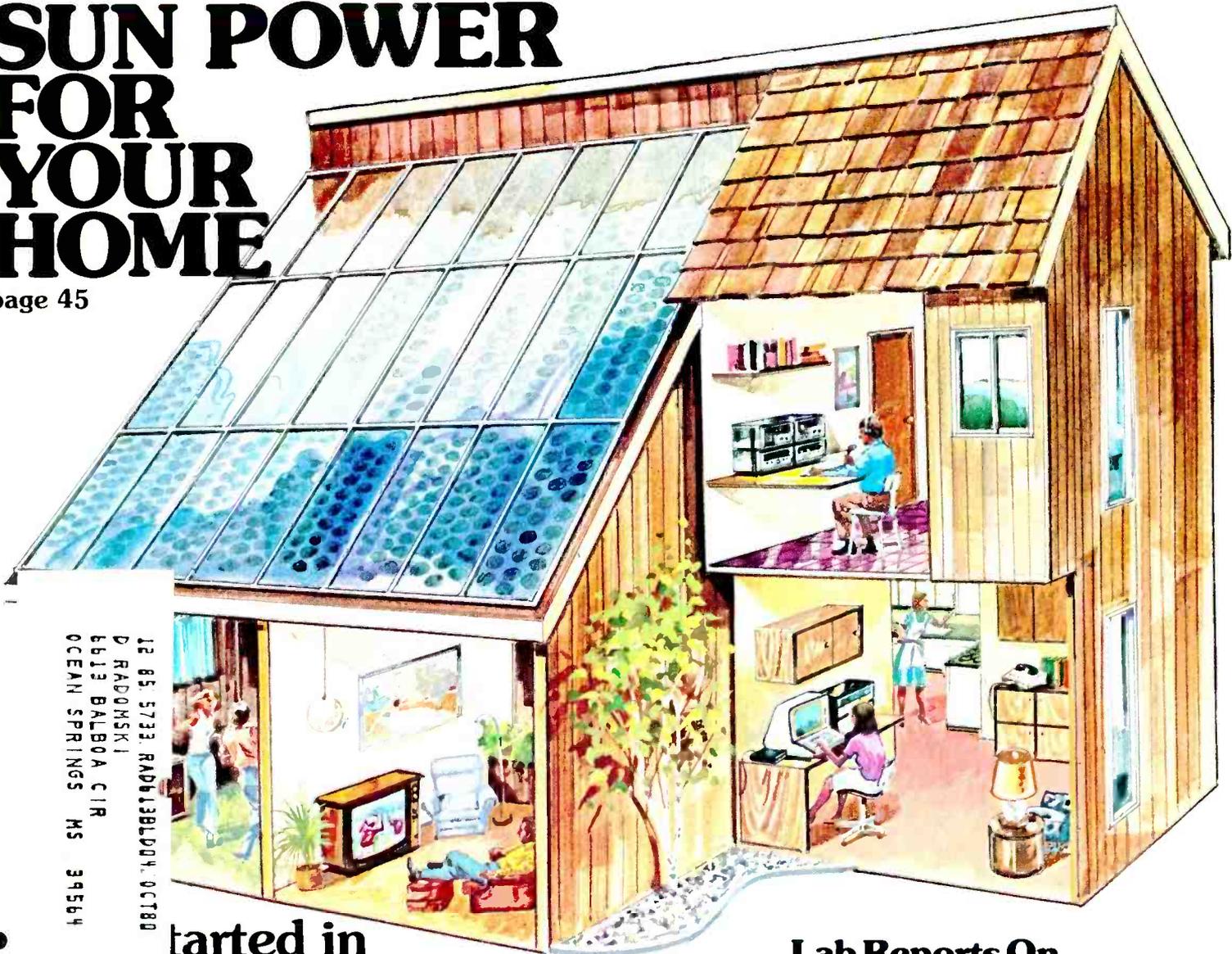
\$1.35
IN CANADA
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elementary Electronics

MAY-JUNE 1980

SUN POWER FOR YOUR HOME

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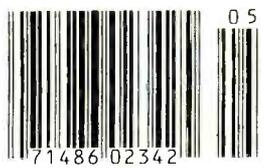


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- started in Home Recording
- Digital Temp Gauge Keeps Cars Cool
- Build Backpack Amp

Lab Reports On...

- ✓ Heath H-89 Disk Computer System
- ✓ Panasonic RF-4900 Communications Receiver
- ✓ Radio Shack ET-300 Cordless Telephone



Is Your Car's Electronic Gear REALLY Insured?

NOW AVAILABLE!

WATT WIZARD™

POWER FACTOR CONTROLLER CUTS THE COST OF RUNNING ELECTRIC APPLIANCES BY AS MUCH AS 50% -- AND YOU CAN EVEN SEE THE SAVINGS!

For over a year now, in magazines and newspapers the world over, there have been enthusiastic write-ups on a remarkable new device that can cut your electric bill while helping the U.S. save huge quantities of fuel.

"The NASA/Nola power saver," wrote a **Popular Science** senior editor, "was developed by Frank Nola at NASA's George C. Marshall Flight Center as an offshoot of a program to reduce power consumption in spacecraft motors. Nola calls it a PFC — power-factor controller. I prefer to call it a power saver, however, because that's what it does."

NASA TESTED IT

According to Clyde S. Jones of NASA, "The device has been tested at Marshall Center on over 40 types of motors, with power savings ranging up to 60%, depending on the loading. The motors tested were both single-phase and three-phase, ranging from 1/2 H.P. to 5 H.P. Most motors will show up to 40-to-50% savings when running lightly loaded or unloaded, and some will show 5-to-7% savings at rated load."

NASA's Technical Support Package showed the test results and noted that "The Power Factor Controller applies to induction type electric motors — the most commonly used type in all major home appliances and the most commonly used by industry."

HOW IT SAVES POWER

Popular Electronics explained it this way: "AC induction motors characteristically run at a nearly constant speed that's fixed by power-line frequency and independent of load and supply voltage. When heavily loaded, the motor draws line current that is nearly in phase with the applied voltage... Under light load conditions, the motor develops less torque by allowing more lag between the voltage and current. This reduces the power factor while leaving the current essentially the same in magnitude.

"Though the low power factor means that conversion of electricity to mechanical power is small, the large current causes considerable (heat) losses in the supply lines and motor windings. This is what reduces efficiency.

"To minimize this waste, Nola's device monitors the motor's power factor and, when it detects light load conditions, it reduces the supply voltage... The current, now more nearly in phase with the voltage, therefore does as much useful work as before, but it and the voltage are smaller, resulting in a net savings of electric power."

THE SAVINGS CAN ADD UP

Like everything else, the cost of electric power keeps going up. Not only is the basic rate you pay going up, the power companies have now added on a "fuel adjustment" charge to help pay for running their generators. In 1980, 1981 and beyond, you'll pay more and more for the privilege of running your electric appliances.

*National Aeronautics
and Space Administration
Patent No. 4,052,648*



MERCURY 1980

Right now, the typical consumer pays about \$8 per month to operate a 16.5 cu. ft. frost-free freezer... \$10 to run a 17.5 cu. ft. frost-free refrigerator... \$8.25 for an attic fan operating 12 hours a day... and about \$60 for an air conditioner used during summer months. It's not hard to figure out what you're paying per year just to run **one** of these appliances. And in many parts of the country, the cost is even higher.

That's why Nola's power saver can soon pay for itself, then start reducing your electric bills — the amount of savings, of course, depending on which appliance(s) you use it with.

There's just one catch. Until now, the device has not been **available** — except for industrial models priced at \$80 or more.

INTRODUCING THE WATT WIZARD

Cynex, an American manufacturer of electrical and electronic products and a prime contractor for the U.S. Government, has been licensed by NASA to manufacture Frank Nola's power saver. Cynex calls it the Watt Wizard.

"The Watt Wizard," says Ray Beaucha, the firm's Marketing Director, "regulates the voltage fed into an induction motor, reducing or boosting power as required, when loads go up or down. Simply stated, it makes motors run more efficiently, especially when idling. It reduces motor heat, affording longer motor life and reducing the amount of air conditioning required for cooling (rooms) in summer months. It saves electric power, because kilowatt hours are greatly reduced. And it causes the motor to run quieter."

SIMPLE TO USE

Cynex makes several models of the Watt Wizard (all with solid state design), including the 110 V AC plug-in model we're offering. It's for single phase fractional H.P. motors (less than 1 H.P.) which is the type used in most made-for-the-home freezers, refrigerators, window and attic fans, swimming pool pumps, furnace fans, vacuum cleaners, sewing machines, power drills, etc.

Simply plug the Watt Wizard into any electric outlet, then plug the appliance into the Watt Wizard. There's no wiring required. Unlike some competitor's models (if and when available), the appliance does **not** have to be turned on before being plugged into the power saver. You can leave the appliance — whether on or off — plugged into the Watt Wizard all the time. Or you can move the Watt Wizard to various locations, depending on which appliance is being used. (Better yet, order several Watt Wizards.)

OTHER MODELS AVAILABLE

Air conditioners, washers and dryers require wire-in model. If you lack mechanical skill, you probably need an electrician to install it. We also offer it in 220 VAC single or three-phase.

ADVANCE FEATURES

The Watt Wizard also includes two more unique features. It's fused, so if you accidentally overload the device, it won't burn out. Just change the fuse, which is available at any auto supply store.

And the Watt Wizard features an LED readout, so you can actually tell, at any moment, exactly how much power you're saving — 10%, 20%, 30%, 40% or 50%.

There's a "Power On" light, too. And the Watt Wizard comes with the manufacturer's 1-year limited warranty.

LOW COST — AND A TAX CREDIT

We're offering the Watt Wizard for only **\$39.95**, with **immediate delivery**. Want two? Then it's just **\$37.95** each. Or splurge and get three at **\$34.95** each. Wire-in models for heavy duty motors are **\$6** more for each unit. Add just **\$2.50** postage/handling for each **order** (not each unit).

And next year, when you fill out your tax return, you can deduct a full 15% energy tax credit — for additional savings.

30-DAY MONEY-BACK GUARANTEE

Try the Watt Wizard for up to 30 days. If not completely satisfied, return it (insured) for a full refund.

The sooner you send for the Watt Wizard, the more you can save on your electric bills. To order, send your check or money order to the address below. Or charge it to your Visa, MasterCard, American Express or Carte Blanche credit card. If using your charge card, you can also order via our toll-free phone number:

800-257-7850

(In New Jersey, Call: 800-322-8650)
N.J. residents, add 5% sales tax.

Or mail your order to:

Dept. G Lakewood Plaza
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The Imagination People®

CIRCLE 18 ON READER SERVICE COUPON

AMERICA'S NEWEST, MOST SOPHISTICATED SCANNER IS ALSO THE EASIEST TO PROGRAM SCANNER.

Presenting the new Bearcat® 300 Scanner with Service Search.

It's like having a frequency directory already pre-programmed in your set—to let you tune in all the action at the touch of a button.

The incredible new 50 channel Bearcat 300 Scanner with Service Search is another first in scanner innovation. Another triumph in synthesized spaceage technology. Another first from the leader in real excitement.

Over 2100 active frequencies are pre-programmed into the Bearcat 300 Scanner memory bank. These frequencies are arranged in eleven service categories, as allocated by the F.C.C.

Simply push the police service button, for example. You'll search and find only the frequencies allocated to police—and be able to monitor every local, active frequency. Then they are programmed into the normal scan operation via keyboard entry.

It's that easy. That automatic for every service category—fire, marine, HAM, emergency, air, etc. It's truly like having a frequency directory already pre-programmed in your set.

The new 50-channel Bearcat 300 Scanner brings you every feature you've ever wanted, and then some. 7-band coverage. AM/aircraft and FM. Patented Track Tuning. Automatic squelch. Priority. Automatic lockout. Activity count. Selective scan delay. Direct channel access. Digital display, and a lot, lot more—even a digital clock, and mountings for mobile operation.

The new Bearcat 300 Scanner. Possibly the ultimate Scanner. Certainly the most automatic, easiest to use Scanner ever.

Now that's real excitement.



BEARCAT® 300 SCANNER.

Follow the leader to real excitement.

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Editor
Alan H. Rose, K2RHK

Associate Editor
Lee Lensky, KA2DKT

Associate Editor
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Citizens Band Editor
Kathi Martin, KGK3916

Editorial Assistant
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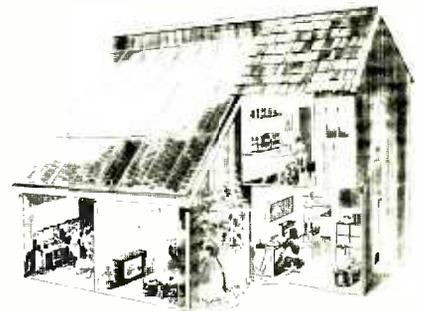
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☆ Cover Stories

AUTHORS IN THIS ISSUE

Craig Anderton, T. J. Byers, James Fred, Larry Friedman, Herb Friedman, Larry Lisle, Paul Margolis, Kathi Martin, Robert E. Montgomery, Nevil Short, C. M. Stanbury, II, Fred L. Young, Sr., Fred L. Young, Jr., D. B. Weems



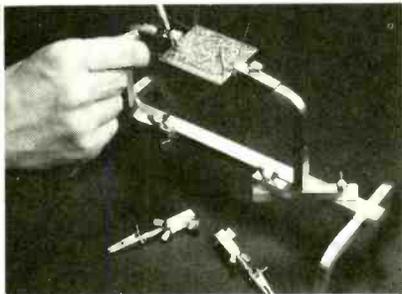
Cover drawing by Ron Macarty

NEW PRODUCTS PARADE

SHOWCASE OF NEW PRODUCTS

Helping Hands

Future Tech, Inc. has introduced the *Hobby Help'r*, a fully-adjustable, all-aluminum hobbyist bench vise. The C-arms pivot 360 degrees, and the adjustable alligator clips attach in a variety of positions to provide just about any necessary work angle. The non-conductive

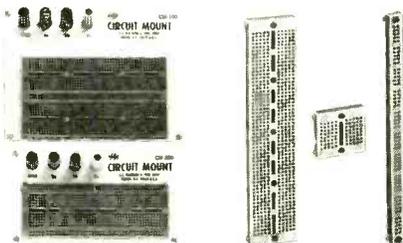


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joints allow complete electrical isolation from the base, making the *Hobby Help'r* ideal for the assembly and testing of any type of electronic circuit. The sturdy base will support up to 50 lb. loads. The *Hobby Help'r* retails for \$29.95. For more information, contact: Future Tech, Inc., 880 Madison Avenue, Mankato MN 56001.

Circuit Mount

The O.K. Machine and Tool Corp. series of Circuit Mount Boards features solderless insertion type sockets on .100-inch centers. Each row has five common points. Larger boards also feature 40-point bus lines, while a separate bus strip module is also available. All boards can accept standard component leads including DIP's,



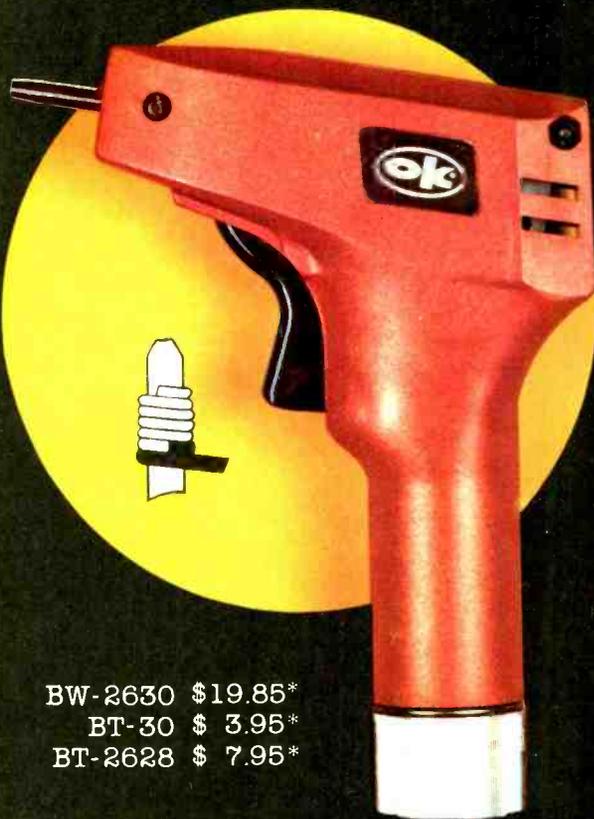
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while interconnections are easily made using standard 22 AWG solid wire. Circuit Mount boards are available in a range of sizes from small modules designed to hold a single IC up to 1020 point panel-mounted boards complete with binding posts. All separate modules are interlocking and also feature screw holes for permanent mounting. Prices range from \$2.45 for the individual CM-400 module, up to \$25.95 for the 1020 point CM-100. Delivery is from stock at local electronics retailers or directly from O.K. Machine and Tool Corp., 3455 Conner Street, Bronx, NY 10475.

(Continued on page 10)



BW-2630 Battery Tool



BW-2630 \$19.85*
BT-30 \$ 3.95*
BT-2628 \$ 7.95*

BW-2630 BATTERY TOOL

The new BW-2630 is a revolutionary battery powered wire-wrapping tool. The tool operates on 2 standard "C" size NiCad batteries (not included) and accepts either of two specially designed bits. Bit model BT-30 is for wrapping 30 AWG wire onto .025" square pins; BT-2628 wraps 26-28 AWG wire. Both produce the preferred "modified" wrap.

Designed for the serious amateur, BW-2630 even includes both positive indexing and anti-overwrapping mechanisms — features usually found only in industrial tools costing five times as much. Pistol grip design and rugged ABS construction assure performance and durability. In stock at local electronic retailers or directly from

OK Machine & Tool Corporation
3455 Conner St., Bronx, N.Y. 10475 U.S.A.
Tel. (212) 994-6600 Telex 125091

*Minimum billings \$25.00, add shipping charge \$2.00
New York State residents add applicable tax

CIRCLE 16 ON READER SERVICE COUPON

If you have put off learning more electronics for any of these reasons, act now!

- I don't have the time.
- High school was hard for me and electronics sounds like it may be hard to learn.
- I can't afford any more education.
- I have a family now.
- I'm here. You're there. I've never learned that way before. I'm not sure it will work for me.

Read the opposite page and see how you can get started today!

Be honest with yourself. Are the reasons really excuses? You already know enough about electronics to be interested in reading this magazine. So why not learn more? If you need encouragement, read on and see how excuses can be turned into results.

You don't have the time. Be realistic. All you have in life is a period of time. Use it. Try to know more tomorrow than you do today. That's the proven way to success. CIE studies require just about 12 hours of your time a week, two hours a day. You probably do have the time.

Electronics sounds like it may be hard to learn. You already know something about electronics or you wouldn't be reading this. Now, build on that. CIE Auto-Programmed® Lessons help you learn. Topics are presented in simple, logical sequence. All text is clear and concise for quick, easy understanding. You learn step by step, at your own pace. No classes to attend. Nobody pressures you. You can learn.

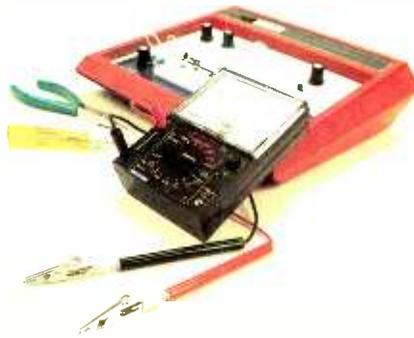
You can't afford any more education. Actually, you can't afford NOT to gain the skills that can put you ahead of the others. You know what inflation is doing to you now. Education—learning a skill—is an inflation-fighter that can be yours. If you are not able to pay full tuition now, CIE will lend you funds on a monthly payment plan.

You have a family now. All the more reason why you have the responsibility to advance yourself. For the sake of your family. Do you want them to have what you had or have more than you had? The choice is yours. Electronics is a rewarding career choice. CIE can help you to get started on that career.

You're there. We're here. How does CIE help you learn? First, we want you to succeed. You may study at home, but you are not alone. When you have a question about a lesson, a postage stamp gets you your answer fast. You may find this even better than having a classroom teacher. CIE understands people need to learn at their own pace. When CIE receives your completed lesson before noon any day of the week, it will be graded and mailed back the same day with appropriate instructional help. Your satisfaction with your progress comes by return mail. That's how CIE helps you learn.

NOW, IF YOU AGREE CIE TRAINING CAN WORK FOR YOU, HOW ELSE CAN CIE HELP YOU?

Cleveland Institute of Electronics is the largest independent home study school in the world that specializes exclusively in electronics. Although "big" does not always mean "best," it is evidence that CIE is a strong, successful institution with the people and resources to help you succeed.



Step-by-step learning includes "hands-on" training.

The kind of professional you want to be needs more than theory. That's why some of our courses include the Personal Training Laboratory, which helps you put lesson theory into actual practice. Other courses train you to use tools of the trade such as a 5MHz triggered-sweep, solid-state oscilloscope you build yourself—and use to practice troubleshooting. Or a Digital Learning Laboratory to let you apply the digital theory that's essential today for anyone who wants to keep pace with electronics in the eighties.



Your FCC License can impress employers.

For some electronics jobs, you must have your FCC License. For others, employers usually consider it a mark in your favor. Either way, your License is government-certified proof of your knowledge and skills. More than half of CIE's courses prepare you to pass this exam. Surveys show that some 80% of CIE graduates who take the exam are successful.

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If you are serious about a rewarding career, about learning electronics or building on your present skills, your best bet is to go with the electronics specialists—CIE. Mail the card or coupon today or write CIE (please mention the name and date of this magazine), 1776 East 17th Street, Cleveland, Ohio 44114.

This could be the best decision you've made all year.

"If you're going to learn electronics, you might as well learn it right!"

*John Cunningham
Senior Technical Director*



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MAIL TODAY!



A VIEWABLE FEAST

British data system brings the world into your home

BY NEVIL SHORT

□ "VIEWDATA," A SYSTEM which uses the telephone lines to communicate to computers and or other home consoles through TV-type CRT displays, was recently unveiled. The Post Office in England has been working on the system for a number of years and hopes that it will soon be fully operational.

The uses for such a device are limited solely by the imagination; and a good number of applications were demonstrated to the international press. Depending on the type of terminal/keyboard arrangement, Viewdata could be a money-making aid to the businessman, a handy accessory for the homemaker, or an invaluable source of communication for the handicapped.

All one has to do is to dial a phone number connecting you to the computer banks you wish to reach. Suppose

you wish to order a book from a library which uses such a system; it would be the same as having the card catalog right in your own livingroom. You would need only to key in what type of material you were looking for, and your terminal would begin to display for you whatever titles were in that area. Find a book you like, put in your order via Viewdata, and the tome you requested arrives with the next day's mail.

Hello, Future! The implications of this advance are truly mind-boggling; almost like something from out of the pages of 1950's science-fiction. If hooks from a library; shares from the stock market can't be far behind. If you can run your finances via the bank's computers; you may soon find yourself registering your vote on instantly tabu-

lated government referendums.

Viewdata is also intended to help the deaf communicate more fully and satisfyingly with the outside world. The system literally makes the visual medium an extension of the telephone. If two people wish to communicate, there would no longer be a need for audio—they could simply type out messages onto their terminals.

Viewdata is likely to touch every part of our lives. If not this system, surely one similar to it. It is an idea whose time has arrived, along with the advent of cheap, powerful microprocessors and mass storage devices. The technology for implementation is already available. The need is there. It seems assured that such in-home, computer communications lie in our not-so-distant future! ■



You may soon be able to tie your home terminal directly into the stock exchanges.



Shop-at-home may take on a new meaning with computerized shopping services.



Direct access to data banks for research purposes may become a leisurely activity.

341 WAYS TO INCREASE YOUR ELECTRONICS KNOW-HOW!

SEND NO MONEY! We'll Invoice you on 10-DAY FREE TRIAL. ALL BOOKS 100% GUARANTEED. You must be satisfied or return the books and we'll cancel the invoice.

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NEW PRODUCTS PARADE

(Continued from page 3)

Budget Equalizer

Superex Electronics, the long time stereophone manufacturer, now offers the GEM-1 five-band-per-channel home equalizer. It is an integrated circuit design featuring center detented linear controls, three tape deck switches for Re-



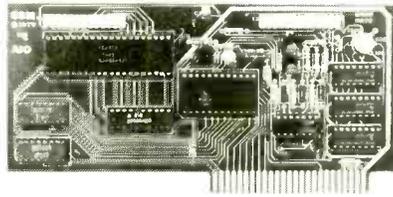
CIRCLE 36 ON READER SERVICE COUPON

cord EQ, Playback EQ, and Monitor, as well as a separate power supply for low noise. The GEM-1 has a programmable EQ Card system which the user contours the cards for specific equalization settings for various source material. When the card is moved up the faceplate of the unit, all the fre-

quency controls are automatically positioned. The GEM-1 also incorporates special narrow bandwidth circuitry for minimum adjacent band interaction. All components are mounted on a single military-grade, glass epoxy PC board. It sells for \$89.95. Get all the facts direct from Superex Electronics Corp., 151 Ludlow St., Yonkers, NY 10705.

Apple Serial & Parallel Interface

SSM's new AIO serial and parallel Apple interface allows maximum flexibility for interfacing an Apple II with peripherals such as print-



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ers, plotters, terminals, modems and other computers. The software programmable serial interface uses the RS-232 standard and includes three handshaking

lines. A rotary switch selects nine standard band rates. The AIO's parallel interface features software programmable I/O ports with enough lines to handle two printers simultaneously with handshaking control. The AIO comes complete with serial interface firmware, two cable assemblies and a comprehensive users manual with easy to follow application notes. It is available assembled and tested (\$175.00) or in kit form (\$135.00). For further information contact SSM, 2116 Walsh Ave., Santa Clara, CA 95050.

Glass-Mounted Antenna

Avanti has just introduced a new 3 dB gain high performance mobile antenna that's specially designed for two-way radio communications. It's called the AH151.3G, a 144-174 MHz antenna that features a sleek new, low contour design and provides improved VHF communications. Avanti has incorporated a higher radiating 1/2 wavelength design that's guaranteed to deliver superior obstruction-free performance over a 3 dB deck-mounted 5/8 wavelength antenna. It transmits a more uniform



Dymek's DR33C Digital Receiver Doesn't Just Receive Digits

- McKay Dymek's DR33C provides quality reception of a wide range of LF-MF-HF transmissions; everything from local and international AM Broadcast Stations, Radio amateurs and professionals using single sideband or CW to News Service Radio Teletype, CB operators and encoded digital data.
- Dymek receivers have been evaluated and are presently used by military and government agencies both foreign and domestic. This same quality is available for personal use at reasonable prices.
- Phase locked loop digital tuning is used

to provide highly accurate and stable reception electronically locked to an internal quartz crystal. Large LED readouts display the received frequency in 100 Hz steps providing rapid and accurate frequency selection.

- Wideband high powered RF front end technology using CATV RF power transistors and a double balanced diode first mixer give extreme rejection of interference caused by strong stations or adjacent frequencies. Wideband technology also eliminates the need for manual peaking adjustments when changing the received frequency.

- Collins mechanical filters are supplied for USB/LSB reception. High impedance audio output is provided for interconnection with HiFi and audio systems. Options include mechanical filters for CW and RTTY, rack mount hardware and 600 ohm balanced audio output.

For more information write or call
Toll Free

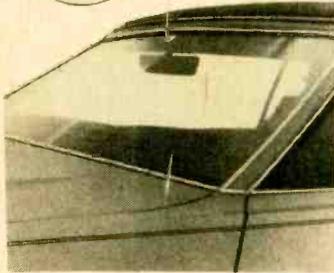
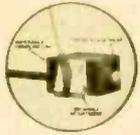
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omni pattern than a "ground plane." A patented "High-Q" impedance coupling unit, with built-in Ritter noise reduction system, mounts inside the vehicle to assure maximum performance throughout the 144-174 MHz band. There are no holes to drill; no car body patching at resale time. A

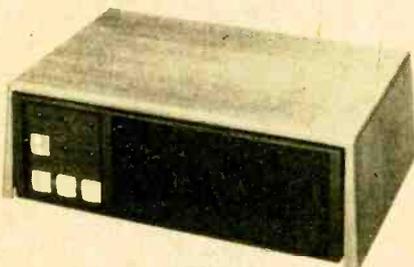


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new aerospace adhesive securely "locks" antenna mount to glass with the strength of a 1/4-inch bolt, yet it can be removed instantly for storage, car wash, or theft protection. Guaranteed to hold securely under even abnormal weather conditions and excessive vibrations. The antenna sells for \$33.95. For more information, contact Avanti Research and Development, Inc., 340 Stewart Avenue, Addison, IL 60101.

RF Disturbance Alarm System

The Safehouse RF Field Disturbance Alarm System, a motion detector device, can protect an area of up to 50 feet in length and up to 5,000 cubic feet with an invisible beam of energy that detects motion. The system is computer-



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controlled and the panel keyboard can be turned on or off with an exclusive 4-digit personal code that only the owner knows. The system also features a computer-

ized sensor and a high-power siren alarm amplifier. Two optional external blast-horn speakers may be used with the system—one mounted inside the home to frighten intruders, the other mounted outside to alert neighbors. Only the actual movement of an intruder walking through the protected area will set off the alarm. The alarm is not affected by traffic noise, air conditioner turbulence, telephones or strong outside winds. The system includes a 30-second delay that allows you to turn on the alarm and leave the premises, and a 20-second delay to turn it off upon return. When an intruder is sensed, the alarm sounds for eight minutes, then shuts off automatically and resets. The Safehouse RF Field Disturbance Alarm System is priced at \$179.95. A-1 three units are available at participating Radio Shack stores and dealers nationwide.

Radio Cap

A cleverly concealed portable radio that enables music lovers to listen to their favorite station without the burden of toting their transistors, is now available. The Bloke's Radio Cap is a blue denim hat powered by a single 9-volt



battery, providing safe, lightweight sound through an earpiece which may be hidden in a secret pocket when not being used. The volume control and station selector knobs are disguised as two buttons in this one-size-fits-all cap. Designed in England, the Radio Cap is sold exclusively in the U.S. by Edsuo, Inc., 3716 Waverly Avenue, Sea-

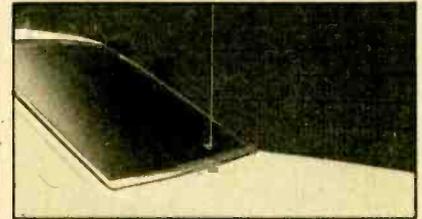
Auto Sound AM-FM Antennas

By Scott Larkin

How the NEW Avanti AFM-1 Improves Mobile Radio Reception

After one million antenna systems, a dozen years of technical research and several hundred patent claims...The AFM-1.

AVANTI, a recognized world leader in Antenna Systems, introduces a revolutionary new technical advancement...the new exclusive "on glass" design that is proven 8 ways better:



Avanti's new AFM-1 — the mobile antenna that mounts anywhere on glass while giving you high-performance sound!

Eliminates "dead" spots.

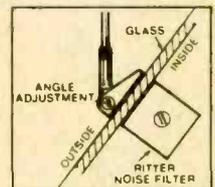
Avoids signal shift.

Cuts unwanted noise with exclusive "Ritter" noise control box circuitry.

Superior gain performance. This means better reception at a greater distance from the transmitting station.

No damaging holes to drill at installation time, nor expensive "patch" jobs at resale time...it installs in minutes without tools, adheres directly to the glass, cannot mar vehicles.

No external electrical connections to corrode and detune. No water leaks...coupling unit is weather-safe inside the vehicle.



Ends inflexible "one position" mounting and high identity problems...The sleek silhouette blends in handsomely with the vehicle styling, offers a full 180° tilt angle adjustment on front, back or side windows.

Backed by AVANTI's uncompromising standards for quality and performance, each antenna is guaranteed to perform as well as or better than the antenna it replaces or your money will be refunded.

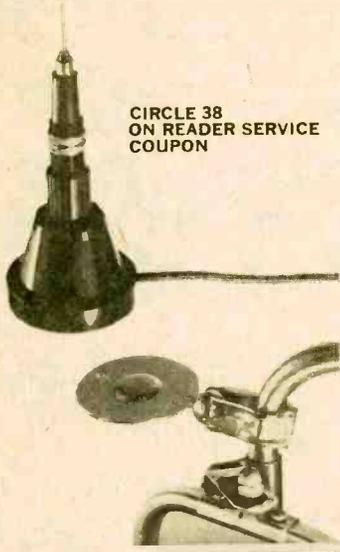
So, if you're tired of a car radio that's not making beautiful music, the AFM-1 is all you need to get it sounding crystal clear again. For more information contact Avanti Research and Development, Inc., 340 Stewart Ave., Addison, IL 60101. 800-323-9429. Illinois Residents 312-628-9350.

NEW PRODUCTS PARADE

ford, NY 11783. It is priced at \$10.95 plus 75 cents for postage and handling.

Special Magnet Mount

A new CB antenna company, Lam-Tech, Inc., has an interesting B60 Universal Mount on the market in



CIRCLE 38
ON READER SERVICE
COUPON

addition to their new line of antennas. It consists of a magnet plate and swivel clamp that lets you position your magnetic mount antenna on any vehicle, steel boat rail, motorcycle, VW, truck and station wagon. All metal parts are triple plated to eliminate rust. The B60 sells for \$7.54. For more information on this product and their Bandit I tuneable antenna, write to LamTech, Inc., 501 Glengary, Holland, OH 43528.

Four More for Good Audio

Four new high fidelity Home Speaker Systems from Audiotex of GC Electronics feature a unique total motor system which results



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in higher than normal efficiency for acoustic suspension speakers. Now available is the 8-in., two-way system (Cat. No. 94-1200) with a suggested retail price of \$59.95 each. An 8-in. woofer and

a phenolic-ring tweeter get the most out of this compact cabinet. Power handling capacity is 35 watts RMS with a frequency response of 45 to 20 kHz. A 10-in. woofer and brilliant wide-dispersion phenolic-ring tweeter highlight the Audiotex 10-inch, Two-Way System (Cat. No. 94-1300), which carries a suggested retail price of \$69.96 each. The system handles 35 watts RMS power with a frequency response of 40 to 20 kHz. Enjoy lifelike reproduction of sound with the new 10-inch, Three-Way System (Cat. No. 94-1350). A deep-throw 10-in. woofer, 4½-in. hardback midrange and phenolic-ring tweeter create an unbeatable combination of power plus performance. Power handling capacity is 40 watts RMS with a frequency response of 40 to 20 kHz, and it sells for \$89.95 each. Engineered for the hard-to-please audiophile is the 12-inch, Three-Way System (Cat. No. 94-1400) with a \$99.95 price tag. Natural sound emanates from an acoustic suspension system with a 12-in. woofer, 4½-in. hardback midrange and wide-dispersion phenolic-ring tweeter. The system handles 45 watts RMS with a frequency response of 35 to 20 kHz. Audiotex speakers are manufactured from start to finish in GC's own 50,000 sq. ft. speaker plant. Audiotex makes them, tests them and backs them! Get all the facts from Audiotex Division, GC Electronics, 400 South Wyman Street, Rockford, IL 61101.

Pinball Game Kit

The Brunswick Aspen pinball machine, in a new build-it-yourself kit, is available now from Heath



CIRCLE 1 ON READER SERVICE COUPON

Co. The machine features electronic memory that holds scores for up to four players and indi-

(Continued on page 14)

TURNER[®] CB BASE LOADED Antennas





Roof mount with screw-in connector.

Trunk lip mount with screw-in connector.

- Spring-loaded, pure brass coil contact pin assures solid, corrosion-free cable connection.
- Exclusive screw-in antenna cable connector (patent no. 4,090,030) provides simple, low loss solderless connection.
- Weather resistant Noryl coil cover is impervious to the elements. Outlasts others, even in salt spray areas. Holds like-new appearance longer.
- Base plate triple chrome plated for corrosion-free, attractive appearance.
- Double thick trunk lip bracket will not break.
- Entire antenna is at d.c. ground for super, low noise reception.

- Three grippers adapt mount to any hole 3/8 to 3/4 inch in diameter

Exclusive roof top mount (patent no. 3,492,769) allows quick, solid mounting on vehicle surface.



Turner outperforms others on the four most important factors: power, performance, quality and engineering. When choosing your next CB antenna - check us out.

- ✓ **500 watt power capacity**
- ✓ **1.1:1 SWR**
- ✓ **Built to last**
- ✓ **Easy to install**

Turner Base Loaded Antennas are available in five different models including swivel ball models for slant backs. Convenient combination mount models include mounting brackets for both trunk lip and roof mount in one antenna.



SK110 Roof
SK210 Trunk lip
SK211 Trunk lip with swivel
SK260C Combo. trunk & roof
SK261C Combo. trunk & roof with swivel

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The B&K-PRECISION 1650 was designed to fill your bench power needs for both linear and digital circuitry. The exclusive opto-isolator controlled automatic tracking circuit allows the B output to precisely track voltage changes of the A supply, while maintaining complete electrical isolation.

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NEW PRODUCTS PARADE

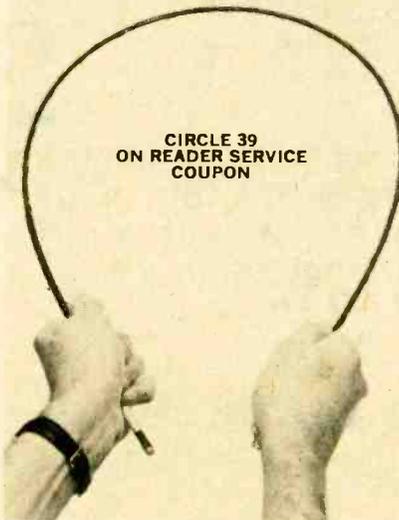
(Continued from page 12)

icates which player is shooting, which ball is in play and when the game is over.

Fun is added by double bonus scoring. It even has musical melodies that tell when bonus points are scored and when the game is over. The kit price is only \$529.95 for the full-size Aspen model, which takes about two evenings to build. For complete details on the Brunswick Pinball Machine and on nearly 400 exciting kits for home, work or pleasure, send for the newest, free Heathkit Catalog. Write to Heath Co., Dept. EE1, Benton Harbor, MI 49022.

Super Whip

A high-strength fiberglass whip that can bend 360-degrees to resist impact is the latest achievement from Avanti Research. The high performance antenna, called "The Skinny Stick," is 48-inches

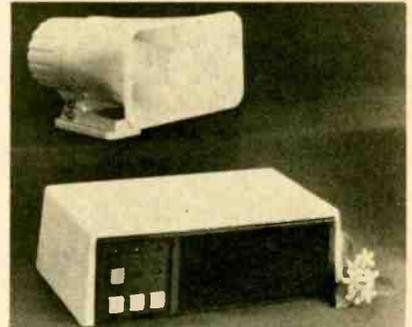


CIRCLE 39
ON READER SERVICE
COUPON

long and has a 1/4-inch diameter. No wire tips to snag or bend, no windings to cut or unravel, plus pin tightening, are all featured on Skinny Stick. The foil band allows for precision tuning and is retunable, while the top-loaded coil gives the whip added punch and better reception. The whip fits standard 3/8-24 thread mounts; power capacity is 150-watts. For more information on The Skinny Stick, which is priced at \$12.95, write to Avanti Research and Development, Inc., 340 Stewart Avenue, Addison, IL 60101.

Home Burglar Alarm

With over 3 million home burglaries reported last year (authorities estimated twice as many went unreported), the 54 Heathkit Electronic Centers in 28 states are about to introduce a remarkably effective device that does what



CIRCLE 41 ON READER SERVICE COUPON

most custom-installed burglar alarms do. It's the MIDEX-55, a compact, professional-grade home burglar alarm system that uses sophisticated motion sensing electronics to detect, then startle and drive off intruders. The MIDEX-55 is capable of emitting up to 120 decibels of sound. It can be installed in just three minutes, activated with the push of a button and, best of all, it sells for under \$250 complete. Designed for use in the home, apartment, weekend retreat or small office, the MIDEX-55 system consists of just two components: a combination transceiver control unit (\$199.95) and a companion blast-horn speaker (\$39.95). Operating off normal house current, the MIDEX-55 can be set up by connecting the speaker wires to the back panel of the control unit using only a screwdriver. To ensure performance reliability, Solfan Systems, Inc. tests each component part of the MIDEX-55 control unit at extreme tolerances and then individually bench tests each assembled system under full power for seven days. This pre-shipment testing is designed to simulate three full months of continuous use, and is further backed by an unconditional one-year warranty for all parts and labor. Solfan Systems also maintains a "consumer hot line" toll-free telephone number: (800) 227-8065. Or, write to Solfan Systems, Inc., Midex Consumer Division, 665 Clyde Avenue, Mountain View, CA 94043. In either case, tell Solfan, "ELEMENTARY ELECTRONICS sent you." ■

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

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- SOLDERING IRON
- 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

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."

SOLID STATE

Today an electronics technician or hobbyist requires a knowledge of solid state, as well as vacuum tube circuitry. The "Edu-Kit" course teaches both. You will build vacuum tube, 100% solid state and combination ("hybrid") circuits.

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. 602-DJ, Hewlett, N.Y. 11557

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

NAME

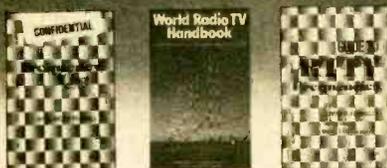
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DX CENTRAL REPORTING

A WORLD OF SWL INFO

BY DON JENSEN

□ Pirate broadcasters—those so-called stations that operate without benefit of license or approval—seem to be cropping up all around the country these days. And, as law-abiding citizens, we can't condone them; but as DXers, we can't ignore them either!

From the west coast, east coast, midwest, and Canada, reports are

coming in concerning these illicit broadcasters. Some seem to operate just above the upper end of the regular AM medium wave band, about 1610 to 1630 kHz, while others work amidst the ham bands. There are some operating in frequency ranges long used by similar pirate broadcasters in Europe, particularly between 6,200 and 6,300 kHz shortwave, and to a lesser extent, above about 7,300 kHz.

Most of the North American pirates seem to be juvenile ventures. Technical competence is limited, and stations are shortlived, either because the operators lose interest or are shut down by the Federal Communications Commission.

Good Pirates. One exception to the general rule is WDAB, a Daytona Beach, Florida, shortwave pirate that had been operating, sporadically, for more than a half year at this writing. WDAB's programming is good enough to make one wish that the station was legit. If you've heard this one, you may have wondered about its operations. So, here is the anatomy of a pirate broadcaster.

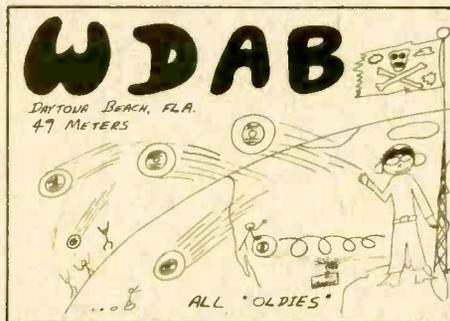
According to station disc jockey Ron Kay, the reason WDAB sounds so professional is simply because it is run by professional radio broadcasters. Ron prefers to describe the station, which operates close to 6,213 kHz in the 49 meter shortwave band, as "an unofficial, experimental station. We simply need an occasional change from the kind of music we're exposed to every day."

Ron explains that he can't play the sort of music he likes at work, so "WDAB becomes a great escape" to play the sort of music he really enjoys, "oldies from 1955 to 1975."

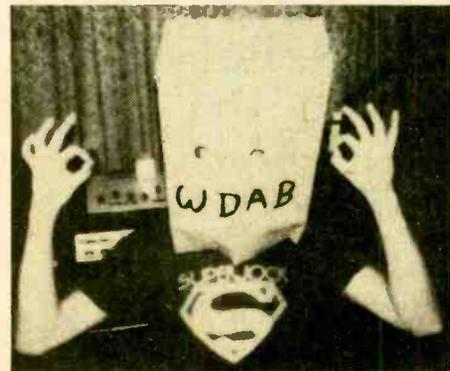
Also, Ron says he wants to prove that shortwave broadcasting can be accomplished on a nationwide basis, maybe even worldwide, with very low power. Low power is WDAB's thing. The transmitter is a Heathkit DX-60B, a ham band transmitter, modified to plate rather than grid modulation. It feeds 50-watts of power to a simple dipole, about 35-feet above ground.

"We have a collection of about 800 45s and 100 albums, a total of

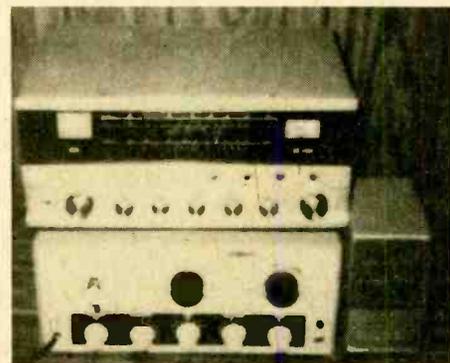
(Continued on page 80)



Daytona Beach's pirate station, WDAB, plays all "oldies," as advertised on its skull and crossbones-decorated QSL card.



Chief honcho of WDAB, Ron Kay, in disguise. Ron seems aware of the problems of running an unlicensed operation.

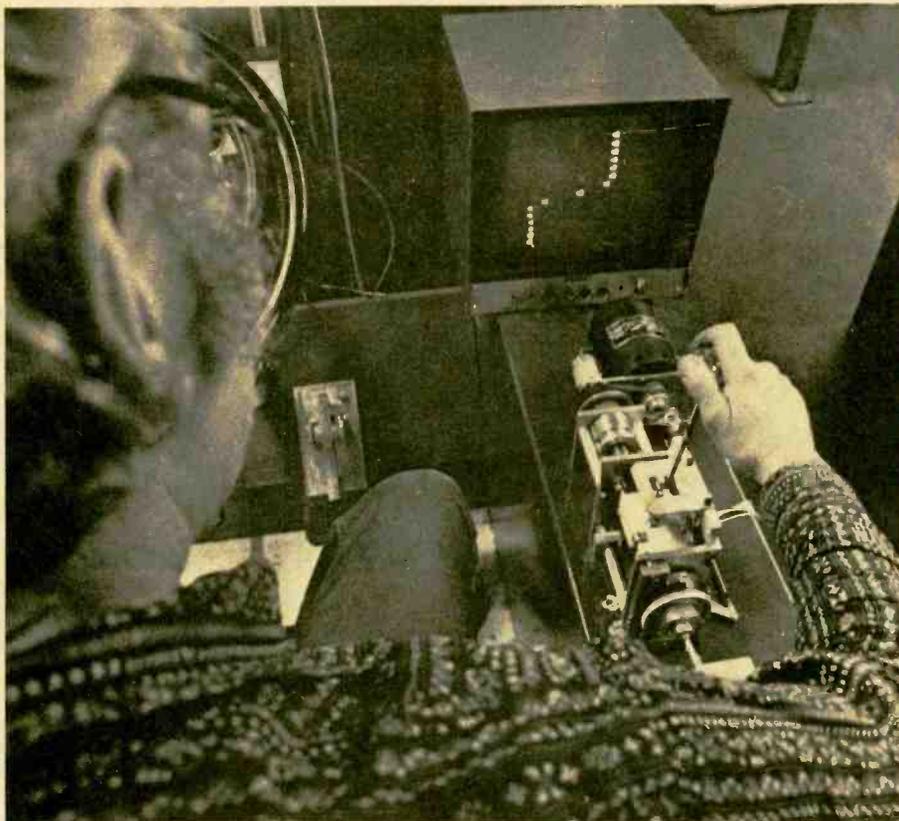


The transmitting facilities of WDAB produce low power from this Heathkit DX-60B.

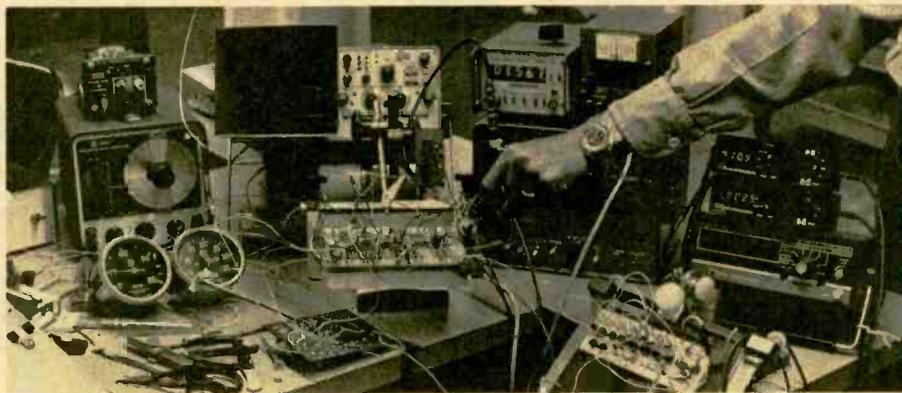
COMPUTER SHIFTS GEARS

Truck driving schools shift to electronic gearbox

BY FRANK MERTZ



The simulator unit is equipped with the usual clutch, brake and gas pedals, gear shift lever, speedometer, tachometer, steering wheel and a computer interface; it even has an ignition key. An instructor can monitor the student with the computer and instruments (lower right photo). These tell if the driver is in the correct gear for the situation at hand.



□ UNTIL RECENTLY ANYONE who has ever taught someone to drive a standard-shift car or truck would sympathize with the instructors of Brooklyn's Driver Training Institute. Imagine the never ending squeal of gear teeth biting into each other as rookie truck drivers make their first attempts with a standard transmission. You can almost hear the stomach turning grunch that happens when a shift up to third becomes an unexpected, extremely noisy and sometimes very expensive shift into first.

Now the Institute doesn't have to worry about expensive gearbox repairs or frazzled instructors—its students are taught to handle a manual transmission by a new electronic truck simulator. This simulator shows “where,” “why” and “how” to coordinate the clutch, gearshift and throttle of a large truck. The unit can be controlled manually or by computer, which gives a printout of the student's proficiency. The computer monitors gear selection, clutching and gas pedal movement, and relates them to various factors which affect the “truck's” performance, such as loads, hill climbing, winds, ice and many other factors. If the student tries to move too-heavy a load up a hill in too-high a gear the unit will stall just like a real truck would.

A driver who has experience driving an automatic can learn to handle a standard transmission in about two hours of hard work on the simulator. The dashboard has a speedometer, tachometer and an electronic print-out of what the driver is doing wrong at any one time or what to do next.

An analog computer called MOVAC simulates the action of the truck and controls the readout on the speedometer and tachometer. Up to three additional simulators can be attached to the computer set thanks to a four-channel encoder. Thus, four learners can grind their electronic gears without cutting their teeth on the very-expensive real thing. This New York outfit has discovered some very real fuel savings as well. ■

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TV Broadcasting



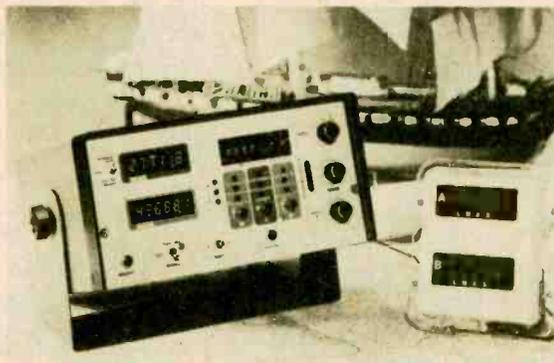
Antenna Systems



Marine Communications



Aviation Communications & Navigation Systems



Direction Finders, Loran



Radar



No other home-study course gives you such complete, professional training in so many fields of communication. No other gives you the actual bench training with kits and demonstration units specially designed for learning. Only NRI gives you the thorough preparation and training you need to achieve professional competence in the wide world of communications.

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meter and digital CMOS frequency counter. NRI even gives you special lessons to get your Amateur License so



you can go on the air with your VHF transceiver.

FCC License or Full Refund

In all, you get 48 lessons, 9 special reference texts, and 10 training kits... the training you need to become a professional. And NRI includes training for the required FCC radiotelephone license examination. You pass or *your tuition will be refunded in full*. This money-back agreement is valid for six months after the completion of your course.

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NEWSCAN

ELECTRONICS IN THE NEWS

Expanding National Weather Radio

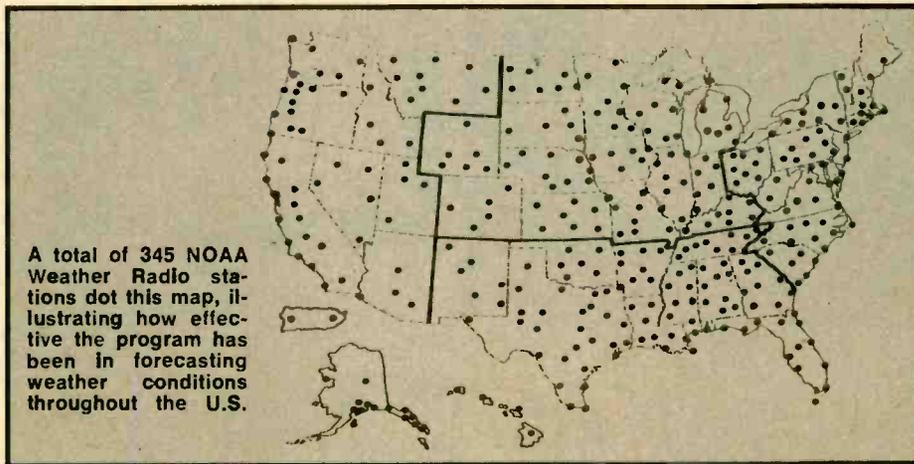
In the early 1950's, the U.S. Weather Bureau established the weather radio program which continues to be developed by its successor, the National Weather Service of the National Oceanic and Atmospheric Administration (NOAA). The NOAA Weather Radio (NWR) program has been expanded to a nationwide network and reached the 345-station goal by late 1979. The system provides weather services on a routine basis and special bulletins. Special warning messages, including possible nuclear attack, can be broadcast during severe weather.

The technical equipment that the NWR program relies on consists of consumer and institutional-grade receivers. Consumer-grade receivers generally have good sensitivity and

tions, both public and private, where large numbers of people are to be found.

When completed, the NWR network will cover all but about ten percent of the U.S. population. These remaining people are in geographical areas where it is not possible for the transmissions to be received because of terrain factors—a valley behind high mountains or a "dead" area not covered by NWR transmitters. Granoff has sponsored the idea for a device known as a Shadow Zone Transmitter (SZT) to cover such areas.

The NOAA Weather Radio network of the National Weather Service will continue to grow and successfully carry out its job of making weather forecasts, advisories, and warnings of impending disasters available to virtually all Americans.



A total of 345 NOAA Weather Radio stations dot this map, illustrating how effective the program has been in forecasting weather conditions throughout the U.S.

poor to fair selectivity, and are relatively inexpensive, easily portable, and powered by either house current or battery, or both. One receiver type may have the option of a warning alarm capability for information on fast-breaking weather events of possible danger to the public. Antennas are generally self-contained within the receiver unit.

Institutional-grade receivers are more ruggedly constructed, have even greater sensitivity and generally good selectivity, and are considerably more expensive than the consumer grade. They are designed for use in schools, hospitals, industrial complexes, and other institu-

Home Exposure with Video Tape

A real estate agent can easily spend an hour and a half showing a prospect a house. Using JVC professional video equipment, a Denver realtor can videotape for display seven houses in that same time.

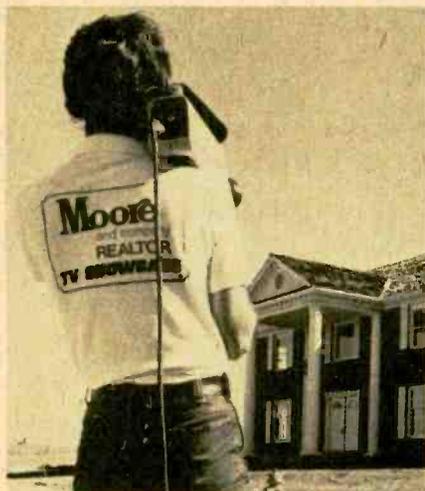
Moore and Company, the second largest residential real estate agency in Colorado, has a wholly-owned, independent production division, Moore Video. Although the real estate market is slowing down in both metro and non-metro Denver, Moore is busier than ever before. Doug Emerich, Moore Video's manager, attributes this largely to a professional video system that gives the company

a huge edge over regional competitors.

"Having a video capacity gives us an excellent advantage in getting the listing," Mr. Emmerich says. "We are the only real estate company in Colorado providing this service. A lot of people are using video in real estate for training," Mr. Emmerich notes, "but very few independent real estate companies are actually reproducing it themselves. Having a studio independent from the sales offices is particularly effective because it gives us the freedom we need to be creative."

Clients listed exclusively with Moore and Company Realtors get the video service free. Once the listing is obtained, the crew tries to tape the house as quickly as possible. A typical production crew consists of one cameraman, an audio person and a production coordinator. The script, written from an outline provided by the realtor, describes the house's special features and any "extras." Moore has three active production crews on call, and equipment available for a fourth as back-up. Production time, including traveling to the site, averages two hours and ten minutes per house.

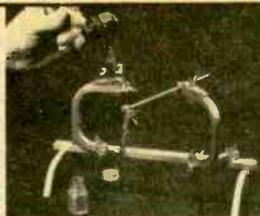
In addition to taping individual houses, Moore Video also has been gathering materials for eventual "mini-documentaries" on the neighboring towns.



Having video capability gives Moore and Company Realtors an edge in getting listings in a tight market. JVC does the job!

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HOE291

NEWSCAN

"We've got a whole script storyboarded," Mr. Emmerich says, "and whenever it's convenient we stop and take a shot of a point of local interest, such as Mile High Stadium. When the weather slows us down from going out to shoot houses, we'll take what we have out of our video bank and put it all together."

911 Has Your Number

Recently, an 82-year-old woman in Alameda County, California, seconds away from a heart attack, dialed 911. Before she could give her name and address, she collapsed. But, thanks to an improved version of the 911 Emergency Communications system introduced by Pacific Telephone last summer, the 911 dispatcher was able to determine quickly the woman's address and a rescue team and ambulance arrived on the scene shortly.

The new Expanded 911 system (E911), designed by Bell Labs and made by Western Electric automatically displayed the woman's phone number on a console in front of the dispatcher. Working from the phone number, the dispatcher cross-checked and found her address.

"That story would have ended differently if we hadn't had this new 911 system," reflects Sgt. Galen Temple of the Alameda County Police Department. "Without it, there would have been no way to trace that call quickly enough to help the woman. You can't realize how many people make emergency calls, and then because of panic, a language problem or simple unfamiliarity with the area, can't tell us where they are," Sgt. Temple said. "With this new system, we immediately know their phone number and can go to work from there."

Bud Walker, product manager for Pacific Telephone, reports, "In each of Alameda's 13 towns, the Automatic Number Identification (ANI) feature of E911 has been greatly appreciated by the emergency personnel. In addition to displaying the phone number immediately, the system keeps a record of every emergency call made. This can be used in follow-up investigations."

Determining the location of the emergency will become even easier when E911 has the capability to display not only the telephone number of the caller, but also his or her street address. Presently, Western

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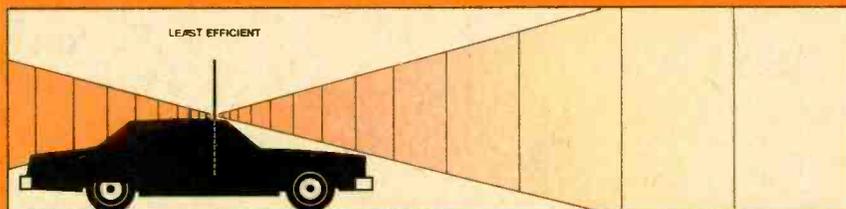
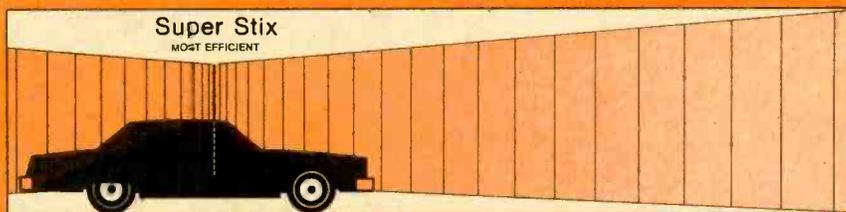
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NEWSCAN

Electric is testing the Automatic Location Identification (ALI) feature and the Bell System expects to offer it to municipalities sometime later this year.

The capability of the system to display the caller's phone number is an aid in solving another problem—crank calls. Sgt. Temple notes, "any emergency system gets a lot of crank calls—especially from kids. They waste our time and tie up the lines. Now, when we get a crank call, we have the phone number and can deal with the person immediately."



There's a fire on Fifth Street, a burglary on Oak and a heart attack victim on Elm Drive! Thanks to a new improved 911 emergency communications system, these 911 dispatchers in Alameda County, CA, will be better equipped to handle emergencies like these.

Another major benefit of Expanded 911 is that it makes it easier to offer service in suburban areas. At one time the system in the suburbs was complicated because telephone office boundaries and municipal boundaries rarely coincide. In suburban areas, one telephone office often serves several neighboring towns. Routing a 911 call to the proper town meant a central answering point has to be established. In a county like Alameda with 13 cities, that would mean a central dispatcher must first determine the caller's location and then forward the plea for help to the right agency in the right town. That all takes time and increases the chance for error because of common street names in different towns.

E911 eliminates the need for a central answering point in suburban areas by automatically routing 911 calls to the town where the caller is located. ■

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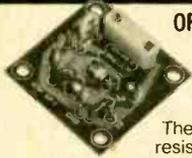


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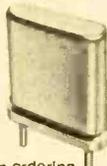
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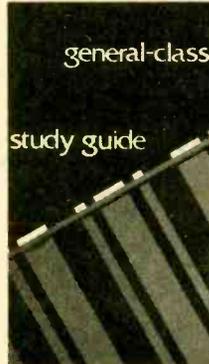
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required receiving code test and written exam covering radio theory and operating rules and regulations. This book was written in simple layman's language with uncomplicated explanations and examples used to present electronic radio concepts and ideas. Published by Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46206.

PPI Chip. *Microcomputer Interfacing with the 8255 PPI Chip* by Paul F. Goldsbrough may be the first book to be published about this newest LSI chip. The book is dedicated to



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teaching the details of the 8255 programmable peripheral interface (PPI) chip—how it functions and how to use it with 8-bit microcomputers. Many microcomputer systems use this chip or a similar PIA or PIO chip. Some examples are the Intel SBC80-10, the Motorola development sys-

tem, the Commodore PET and KIM, Rockwell International AIM 65, SYM I, Apple II, and many others. It is a laboratory oriented text written to give you a thorough understanding in programming, interfacing and designing with the PPI chip. Strong emphasis is on learning through experimentation. Each topic introduced is reinforced with laboratory work that shows not only how ideas succeed but what limitations should be expected. Familiarity with microcomputer input/output (I/O) techniques is assumed, however the first chapter provides a review of both accumulator and memory mapped I/O techniques. This is the 19th book in the Blacksburg Continuing Education Series, published by Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268.

Back in 1923! It's fun, once in a while, to look back at some of the early days of radio (it wasn't called



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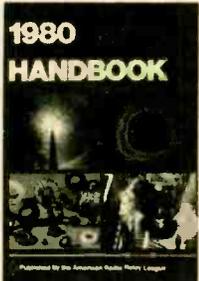
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"electronics" then) when things weren't quite so hectic. Crosley was one of the big names in the business half-a-century ago, and there's a reprint available of their 1923 catalog *Crosley Radio Apparatus* showing all sorts of neat goodies like vario-couplers, detecto-units, duo-amplio units, condenseo-units, crystal receivers, and a whole line of radios—in kit form as well as complete with cabinets. Readers can get a copy of the Crosley 1923 catalog from The Vestal Press, Box 97, Vestal, NY 13850.

The Amateur Bible. The newly expanded edition of the *Radio Amateur's Handbook*, the standard manual and resource book for com-

munications professionals and ham radio hobbyists, is off the press. Charts, tables photographs, schematic diagrams, parts supplier lists and pertinent, detailed information for building, testing and refurbishing amateur radio equipment and accessories make up its 570 pages. Cir-



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uits, filters, cables, antennas, wave propagation, satellite communications and general operating techniques as they relate to the radio amateur are discussed at length in this 57th edition. The book is available at electronics dealers, bookstores or postpaid direct from the American Radio Relay League. For more information, contact Ms. Bobbie Chamalian, ARRL Headquarters, 225 Main Street, Newington, CT 06111.

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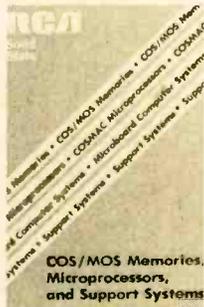
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Learning Level II is even for those who haven't learned Level I. In clear, simple language, the manual explains how to use the Editor, a valuable tool for changing and correcting BASIC programs, both while learning and when custom-writing special programs. *Learning Level II* may be ordered direct from Computer Books Division, CompuSoft, Inc., 8643 Nava-jo Road, San Diego, CA 92119. Add \$1.45 for postage and handling.

For Reference. A 440-page data-book on *COS/MOS Memories, Micro-*

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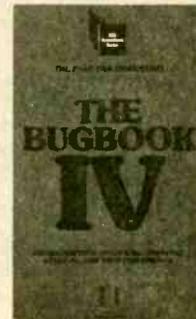
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microboard computer systems, and (4) the CDP18S000 series of COSMAC microprocessor development systems. The data combine definitive ratings, electrical characteristics, dimensional outlines and user information. Copies may be ordered un-

der code SSD260 from RCA Solid State distributors or by sending checks or money orders to RCA Solid State Division, Box 3200, Somerville, NJ 08876.

More on Bugbooks. The latest addition to E&L Instruments' Technibooks Series details the major microcomputer input/output techniques and their implementation using the popular 8255 Programmable Peripheral Interface (PPI) chip. In *Bugbook*



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IV, Microcomputer Interfacing with the 8255 PPI Chip, by Dr. Paul Goldsbrough, with portions of the experi-
(Continued on page 80)

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HI-FI REPORTS

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BY GORDON SELL

THE ONE AUDIO PERFORMANCE FACTOR that is common to every link in the audio chain is *frequency response*—the ability of a component to produce equal output levels at all audio frequencies. Any hi-fi gizmo with a so-called "flat" frequency response should produce the same output level at 20 Hz, 1000 Hz or 20,000 Hz.

Most modern amplifiers have perfect or nearly perfect 20 to 20,000 Hz frequency responses. In fact, we've tested some in the lab that are flat from DC (Direct Current or zero Hz) to well over 100,000 Hz. Most other audio components don't fare so well—they may have poor low frequency response, or bumps in the mid-range or high-frequency roll-off. The best cure for frequency response shortcomings, if you can't afford the gold-plated ultimate audiophile components that have near perfect performance, is to add an equalizer to your audio system.

Equalizers. An equalizer is basically a fancy tone control that will enable you to boost or cut your system's frequency response so that the output will be as close to "ideal" as possible. When I say ideal, I mean flat, but not everyone likes a flat output. Some people like to boost the

bass above flat, while others like a bit of a boost in the high frequencies.

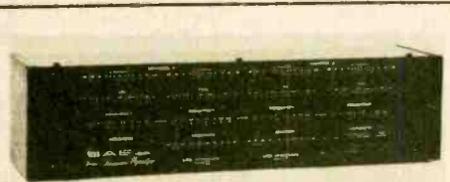
There are two basic types of equalizers; parametric and graphic. Another name you will see is paragratic, but this is just a combination of the two. A graphic equalizer has left and right channel controls that boost or attenuate at specific frequency ranges. A good example that we recently had in the lab was Pioneer's SG-9800 graphic equalizer. It has twelve, ± 10 dB equalizers centered on 16, 32, 64, 125, 250, 500, 1000, 2000, 4000, 8000, 16000 and 32000 Hz. The 16 Hz and 32 kHz equalizers are used to tailor the high and low frequency rolloff curves.

A parametric equalizer is different and usually has a low, and high frequency control that is adjustable for both center frequency and bandwidth, as well as level. Both types have their adherents and detractors. SAE makes a reasonably priced paragratic equalizer called the SAE 180 that's worth taking a look at.

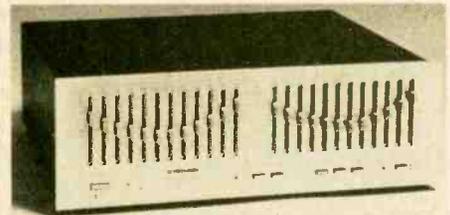
Spectrum Analysis. One problem many hi-fi enthusiasts have is figuring out just what is wrong with their frequency response. The easiest way to see what your system is doing is with a spectrum analyzer, just the way we do in our lab. Unfortunately this is a pretty expensive piece of equipment to put in your living room.

Thanks to modern solid state circuitry and the deletion of a few filters and laboratory gadgets, the Scott company has come up with a \$599 home spectrum analyzer that lets you measure the performance of any component in your system. The Scott company has come up with a tor that creates the test tones, a calibrated microphone for speaker

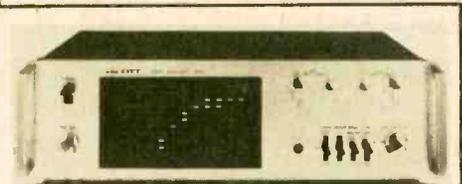
(Continued on page 80)



SAE's model 180 is a parametric equalizer, handling two independent channels. It has low and high frequency range controls, output level and bandwidth controls. Price: \$250. Circle 42 on the reader service card.



Pioneer's SG-9800 graphic equalizer features 12 ranges of frequency control per channel. It has two fixed ranges of level attenuation. Price: \$395. Circle number 43 on the reader service coupon for info.

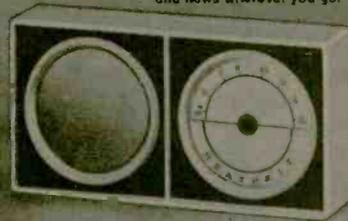


Soon to become a "must-have" item for the audiophile, a spectrum analyzer such as Scott's 830Z directly reads the frequency response of your complete system. Price: \$599. Circle 44 on the reader service card.

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UNTIL THE EARLY 70's, very few musicians could afford to play their music in a recording studio. Studio time was expensive, the equipment necessary to record was expensive, and even accessories (tape, monitor amps, mixing consoles, etc.) were beyond the financial reach of most musicians.

Then a funny thing happened—Quad hit the audio scene. While it never went over big with the average consumer, a number of companies (most notably TEAC) saw that people were still buying plenty of four-channel recorders, despite the fact that the market for audiophile Quad had all but disappeared. After a little research, they found that musicians were buying these recorders not to play back someone else's music, but to create their *own* music. This

discovery led to a rapid development of a new market, to the point where today many musicians have 4-track studios in their homes. A complete 4-track studio—useful for songwriting, demo tapes, education, and just plain fun—can be bought for \$1000. With studio time going for at least \$50 and hour and up, it's no wonder that people are finding it more cost-effective to build their own studios than to rent time at commercial equivalents.

What is Multitracking? Let's begin by reviewing some of the techniques used in the making of a typical pop record. First, you have to record the musicians. Interestingly enough, many times the musicians involved in a record won't even see each other during the recording process.

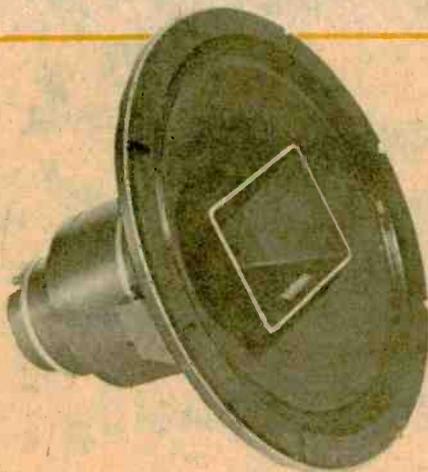


Paul Martin of Dagger

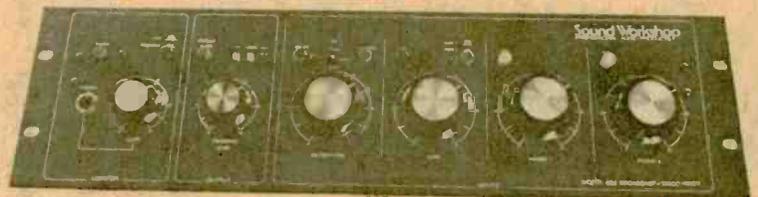
Getting Started in Live Home Recording

The ABC's of setting up a high quality home recording studio on a budget

BY CRAIG ANDERTON



You can realize considerable savings by enclosing your own speaker systems. Altec-Lansing's 604-8H features a 15-inch woofer with coaxially-mounted compression horn, and handles 350-watts. Circle 76 on the reader service coupon. Altec's 1690 mixer (top right) handles eight channels with any switching arrangement. LEDs monitor output levels. Frequency equalization and filtering are built right in. Circle number 76. Intended primarily for disco use, the model 421 mixer by Sound Workshop (bottom right) can be utilized easily for home recording. It has 4 stereo channels and 1 mono mic channel. Patented "Tri-Lite" LED metering system keeps track of output levels. Circle 77 on the reader service coupon for info.



Why? Because not all elements of the song are recorded at once. The percussion and rhythm section will usually be recorded sometime during the first session; then, at separate *overdub* sessions, the vocals will be added. Often times, the vocals are not perfect on the first "take" and must be repeated over and over again until they are right. The song is not yet complete, however. Through a process called *sweetening*, additional overdubbed tracks of vocal harmonies, string sections, lead guitars, synthesizers, and other instruments will be added.

To do all these various tricks you need a *multitrack* machine that's capable of *selective synchronization* (or "sel-sync," a term trademarked by Ampex; other companies use other names, like "multi-sync," "track-sync," and so on). A multitrack machine divides a piece of tape up into a number of tracks, just like a conventional recorder. But whereas a stereo recorder will only be able to record two independent channels of music, the multitrack recorder can record four, eight, 16, 24, or even 40 independent channels! With an eight-track recorder, for example, you can record 8 individual instruments on the tape. Thus if you record the vocal (or any other sound) on a separate track from the other instruments, at a later date you can re-record that sound without disturbing any of the other tape tracks. As a result, you can "assemble" a song piece by piece—editing, keeping, and discarding the individual tracks until you have the song arranged exactly as desired.

None of this multitrack layering would be possible without selective synchronization, though, so let's look at the basic process. Let's say you have drums recorded on one track of a four-track tape. Now, let's also say you want to overdub a bass part to go along with the drums. Normally, you would hear the drum track by monitoring from the tape recorder's playback head. Meanwhile, you're recording the bass part at the record head. However, if you play back both tracks together, note that the drum's sound will hit the playback head just a little bit before the bass, which

gives a displeasing out-of-sync sound. With selective synchronization, the bass track is recorded while listening to the drums via the *record* head. While the record head is not really designed for playback, it does have sufficiently good audio characteristics to justify using it for monitoring a signal. Now, when the bass track is played back with the drums, they both come out in perfect synchronization. Thus, a group of musicians can lay down overdubs to their hearts' content, and as long as they monitor from the record head, the tracks will be in sync.

Mixing. Another important element in the recording process is the *mixing console*. Now that we have all these little pieces of a song spread over a number of different tape tracks, we need some way to blend them together into a unified whole, which becomes our stereo master. By feeding each tape track into the mixer and adjusting the levels and tonal qualities (i.e. bringing up some instruments if they're too soft, fading out a bad note or two, and so on), and then assigning these tracks to different positions in the stereo field (left, right, or anywhere in between), we can record this final stereo mix into another tape machine. This 2-track master is then taken to a mastering lab, where the tape is converted into a master disc from which mass-produced discs can be made.

The Home Studio. A home studio works in a remarkably similar fashion, but there are a few differences. These are: Number of tracks—Professional studios use 16, 24, and 40 tracks. But more tracks means more expense, so home studios generally use either 4 or 8-track recorders; Reliability—Professional studios may be booked 24-hours a day, 365-days a year; as a result, the equipment is built to take constant operation and a certain amount of abuse. In order to keep costs down, home recording equipment is not quite as ruggedly built, but the level of reliability is still more than adequate for the home environment; Staff—At a professional session, there will usually be a producer, chief engineer, and 2nd engineer or tape operator, in addition



A compact, ready-to-play speaker system, Altec-Lansing's model 9842 (left) features a 12-inch woofer and complimentary 2-way compression driver/horn. Available with or without grille in two cabinet styles, each model has electronic overload protection. Circle number 76. TEAC's model 144 mixer/recorder (above) handles 4, frequency-equalized channels, and its built-in 4-track cassette recorder allows mix down right in the same unit, simplifying dubbing chores. Circle 74 on service coupon.

to the performers. In the home studio, however, a single person may assume all these different roles. In fact, one of the nice things about a multitrack studio is that by constant overdubbing, a single musician can create a complete piece of music single-handedly; Intended usage—A professional studio is expected to turn out hits; granted that the ratio

of hits to misses is very small, but people keep on trying. The high cost of studio time also means that experimentation at \$100 an hour is just not possible. Luckily a home studio has no such pressure. As a result, it can perform experimental and educational functions as well as simply providing a method to make demo tapes and record a band. In the meantime, any musician using a home studio is learning valuable engineering and record production skills that are useful in any studio environment.

Getting Started in Home Recording. While most people consider a multitrack recorder necessary to do any advanced studio work, there are simpler (and less expensive) ways to get started. For example, you can do overdubbing with a conventional 3-head stereo recorder if you also have a simple mixer that can mix two signals together. Note that you must be able to engage the record function for each channel separately—ganged record buttons are no good.

As an example, suppose that the musician has recorded some bass guitar onto the tape recorder's left channel. By taking the left channel output, and mixing it in with a new instrumental sound such as a rhythm guitar, he or she can now feed the mixer output into the right channel and record *both* these sounds into the right channel. After recording the bass and rhythm guitar onto the right channel, one can take the right channel output, combine it with another sound (vocal, for example), and feed that into the left channel again. Now the left channel contains three tracks. You can go back and forth, *ping-ponging* between the two channels as many times as desired, although there are some practical limits since each transfer (or *dub*) increases the amount of high frequency hiss and subtly alters the frequency response of the material. Nonetheless, you can typically layer about 5 tracks using this single machine ping-ponging technique.

You'll note that this method precludes stereo mixing, since we have to combine all our different instrument sounds onto one track. Another problem is that by ping-ponging, we have to have the instrumental mix on each track perfect before we move on; once we record over a track it's gone forever. This is very different from true multitracking, where each instrument is kept on a separate tape track.

Another way to experiment with multiple tracks involves the use of two reel-to-reel or cassette decks; what's more, this method allows for stereo recording. You'll also need a mixer capable of accepting 4 inputs.

An example would show a musician recording a drum set through a 4-input mixer, assigning some drums to the right channel and some drums to the left channel, into recorder 1. After getting a good take, the musician then takes these two stereo tracks and mixes them, along with another instrument, into machine 2. This instrument can be either mono or stereo, depending up on the instrument and mixer that you use. Say the instrument is a guitar; we now have a stereo drum track, plus a guitar, sitting in machine number 2.

Next, the musician gets a friend and they decide to do some vocals. By taking the material on machine 2, and mixing it into machine 1 along with the two vocals, the tape on machine 1 will now contain drums, guitar, and vocals—all in stereo.

With either of the above two budget techniques, it's important to use the *best possible tape* and pay careful attention to your recording levels. Also, don't expect to sound like Fleetwood Mac or ELO on the first go-round; the process of learning to run a studio requires a certain amount

Because the tape passes the playback head after the record head, monitoring from the playback head does not let you record the other track in sync. That's why you need selective synchronization. Don't try to modify your standard 2-channel for this purpose. Odds are that you'll do more harm than good.

A tape deck with selective synchronization allows for monitoring of the tape from the record head. This allows you to lay a signal down as you hear it on the same place on the tape. With a 4-track deck, you can put in 4 different tracks on the same tape and each one will be completely independent.

To combine 2 instruments on the same track, first record one (bass guitar). Rewind the tape, and feed the deck into one channel of a mixer. Feed the second instrument through the other mixer channel as you play along with the first. Feed the output of the mixer into the deck's other channel for the dub.

of experience before you start to get a really good "sound." For example, many beginners don't realize that you can "hit" tape pretty hard (give it a high record level) before you get audible distortion. This helps keep the signal-to-noise ratio as favorable as possible.

Preparing a Studio. While professional recording studios use extensive baffling, tuned control rooms and other exotic techniques to preserve the truest possible sound, you will probably not have the money or the space to go to these lengths. You may even have to set up your studio in a closet or a corner of a room, rather than giving it a room all its own. In this case, you may need some soundproofing to keep the peace with your family and neighbors. Heavy drapes, sheets draped across the ceiling, rugs that go up the wall, heavy pillows—all of these absorb sound and deaden the room. While you may lose some high frequencies with too much deadening, at least the chances of losing your lease are reduced.

You'll also need some kind of sturdy table to hold your machine, as well as a place to store tapes that's out of the reach of magnetic fields that could affect your recordings. When creating a studio environment, the key is experimentation—see what works and what doesn't. Some engineers swear by acoustically dead rooms; others say that live sound is the only way to go—let your ears be the judge.

Other Accessories. You'll need some way to monitor the results of what you've recorded, which means a monitor amp and some speakers. Any hi-fi amp will do for the monitor; if you wish to save a few bucks, headphones will give adequate results for less money.

Maintenance. Luckily, maintaining a home studio is not a difficult process. All you really need to do is clean the tape heads, capstan/pinch roller combination, and other parts of the tape path with a suitable type of head cleaner. Most people use Q-tips and distilled alcohol for cleaning, although I think it's worth the few extra pennies to get a type of head cleaner designed specifically for tape recorders. Check

to make sure that the cleaner you get is considered safe for plastic and rubber products; the wrong type of fluid may cause cracks in the pinch roller.

Most people know how to clean a tape recorder (and if they don't, the machine's instructions will tell them how), and yet, they don't take the time to perform this routine maintenance. Rather than recap the cleaning process, then, let's discuss why it's so important.

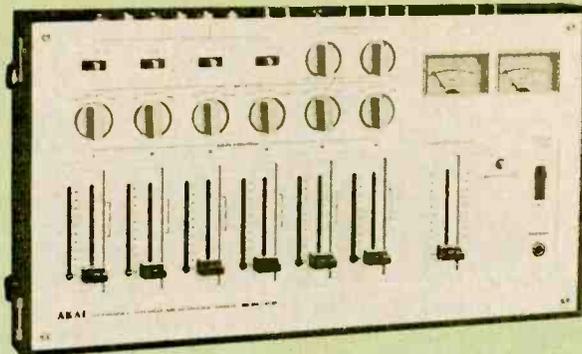
As tape travels through the machine's transport, little pieces of oxide and binder can flake off, leaving a small deposit on the tape heads. These heads are machined to incredibly precise tolerances, and a build-up of dirt not only affects the performance by eliminating the chance for intimate contact between the head and the tape; it can cause more rapid head wear. Tape being dragged across a head is bad enough in terms of wear, but if it's dragging lots of little particles at the same time, you have an abrasive action that is very detrimental to the tape recorder. In addition to watching out for dirt, many conscientious tape operators avoid smoking in the vicinity of a tape recorder. Smoke particles are about 250-microns in diameter, which, when allowed to accumulate on a tape head, can again cause substandard tape-to-head contact. If you clean your heads every few hours, you insure that your tape recorder will give as many years of trouble-free operation as possible.

The only other regular maintenance required is the demagnetization of the tape heads. As you record and play back tapes, the heads build up residual magnetism. Unfortunately, if this residual magnetism reaches a high level, it will partially erase tapes going past it, since it becomes more like an erase head than a recording or playback head. Demagnetizers are inexpensive accessories, and they should be used in strict accordance with any enclosed instructions. Demagnetization is required about every 6 to 10-hours.

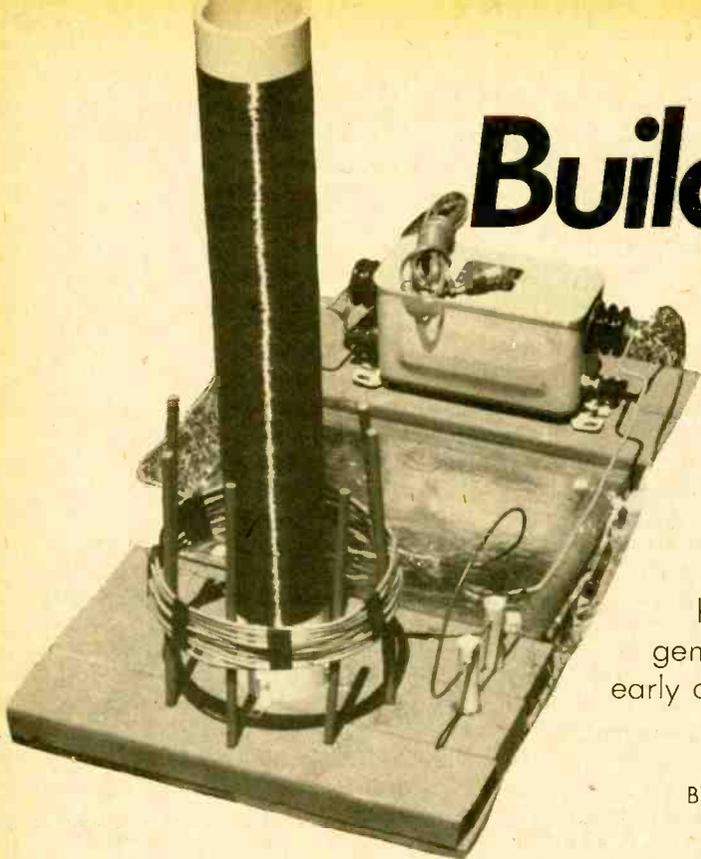
More Advanced Multitracking Techniques. For the highest possible sound quality, a true multitrack machine de-

(Continued on page 81)

A real studio-oriented deck, such as Otari's MX-5050 (right) carries a substantial price tag, but it can be justified in the longer service life a unit of this caliber provides. Circle number 75 on the reader service coupon. AKAI's glass head decks have always been favorites with home recordists. The "Quadra-Sync" feature on the GX-630D SS (center) allows for selective synchronization. Circle 73 on the reader service coupon. AKAI's MM-62 mic/line mixing console (left) handles 6 mics, 4 instruments and 2 phono or tape monitors. It's battery-powered, completely portable and weighs only 8.1 pounds. Circle No. 73 on the reader service coupon.



Build a Tesla Coil



Amazing
high voltage
generator from the
early days of electronics

BY LARRY LISLE

ERIE FINGERS OF PURPLE electrical fire! Fluorescent tubes that glow in midair! Man-made lightning that crackles and sparks!

Tesla coils have been used to create these effects and others since they were invented by Nikola Tesla in 1891. When the principles are understood they're remarkably simple, but to the uninitiated they seem like something from outer space!

The one that's described here is about as easy to build as an electronic project can be, but it will sure pep up a magic act, give the competition a run for its money in a science fair or spark interest in electronics in the classroom.

The Tesla Coil circuit is no more complicated than a crystal set. Transformer T1, a neon sign transformer, is used to boost ordinary 120-volt, 60-Hz. house current to about 30,000 volts. This higher voltage is used to power a spark oscillator that generates radio frequency current in coil L1. Coils L1 and L2 are tuned to the same frequency (about 700 kHz) and form a transformer that multiplies the voltage tremendously, creating the startling displays described earlier.

The neon sign transformer is the only part that will have to be purchased. These can usually be picked up used for around \$10 from sign companies. All the other parts can be made at home with simple tools.

High Voltage Coil L2. Coil L2 is simply a one pound spool of #24 enameled wire wound on a 3/2-in. outside diam-

eter piece of PVC or plastic pipe, 26-in. long or longer. A cardboard tube can be used if coated with an insulating compound such as "Q-Dope."

Drill a small hole just large enough to pass the wire 3/4-in. from the bottom end. Then drill another small hole 1/2-in. above it. Push about a foot of the #24 wire into the upper small hole from the outside and pull it out the bottom hole. Then start winding. A lathe or winding jig will make the job faster, but it can be done by hand in a few hours. That's how I did it.

When the spool is empty, drill another small hole near the upper end of the winding and push about a foot of wire through it and pull the wire out the end of the tube. This will be the discharge end of the winding.

Fasten four small angle brackets to the bottom end of the tube with bolts, and the coil is finished. Be sure that the metal angle brackets don't come too near the coil wire, a space of 2 1/2-in. is a safe distance.

The high-voltage coil and all other parts are mounted on a piece of 1/2-in. plywood, 18-in. by 29 1/2-in. Three 2x4s are glued across one end of the plywood to make a base for the two coils. Do not use nails or screws too near the electrical components.

Temporarily place coil L2 on the 2x4s and mark its location. Then draw an 8 1/2-in. diameter circle around the outline of L2. Drill eight evenly spaced 3/8-in. holes around the circle, and place in them the ends of eight 12-in. long

pieces of 3/8-in. dowel rod. The dowel rods will be the form for coil L1.

Drill a hole in one of the dowel rods that's located nearest the far end of the plywood base. Insert the end of a length of #10 insulated wire through the hole and pull a couple of feet through. Wind a ten turn coil around the eight dowel rods, then cut the wire at the end of the tenth turn and secure it by looping it once around the dowel with the hole in it. The bottom of the coil should be 4-in. above the 2x4s while the top should be 6-in. above the 2x4s. The turns of the coil can be held neatly in place with loops of plastic tape.

The Discharge Capacitor. The capacitor (or condenser) C1 is made with sheets of glass and tinfoil. I used sheets of glass from old picture frames 12 x 16 x 3/64-in.

Place one layer of glass on the plywood with its edge against the 2x4 supporting L1 and L2.

Cut a piece of tinfoil 9 1/2 x 16 in. carefully with a razor blade, making sure that the foil is smooth and wrinkle-free. Place it on the glass sheet so there is a border of at least an inch on three sides of the foil while the fourth side overhangs the glass. Tape the foil in place at the corners.

Now place two sheets of glass over the foil. Take another piece of tinfoil the same size as the first and place it on top of the glass, this time having the foil overhang the glass on the opposite side of the capacitor from the overhang of the first sheet. Tape the foil in place. Place two more pieces of glass on the assembly and add another piece of foil which overhangs the glass on the same side as the first piece and tape it down.

Add two more sheets of glass and another piece of foil overhanging the glass on the same side as the second piece of foil. Place two more sheets of glass on the assembly. Put a final piece of tinfoil in position, overhanging on the same side as sheets 1 and 3. Put a final piece of glass on the capacitor.

Now take the ends of sheets of foil one, three and five together and fold them over twice to form one terminal of the capacitor. Do the same on the opposite side with sheets two and four to form the other terminal.

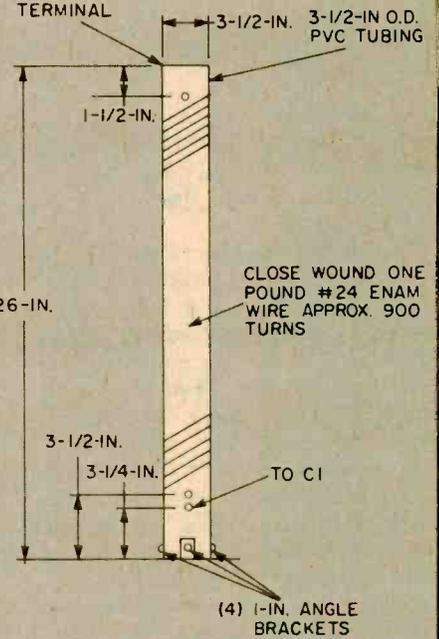
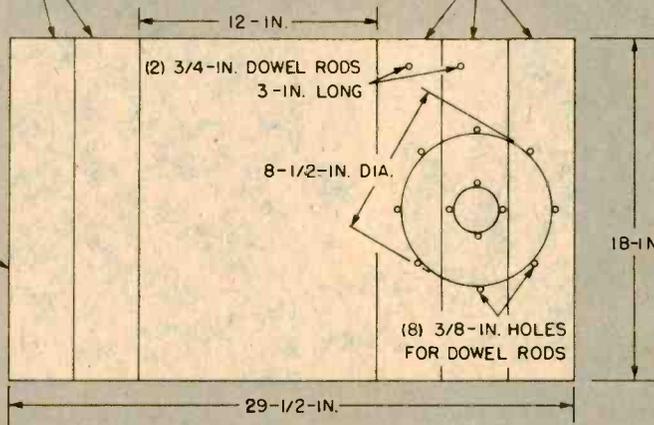
Note: There should be at least 5/32-in. of glass between the sheets of foil. Thicker glass may be used with lessened efficiency, but less than 3/32-in. may re-

BASE FOR TRANSFORMER
(2) 2-IN. X 4-IN. X 18-IN.

BASE FOR L1, L2 AND SPARK GAP
(3) 2-IN. X 4-IN. X 18-IN.

HIGH VOLTAGE
TERMINAL

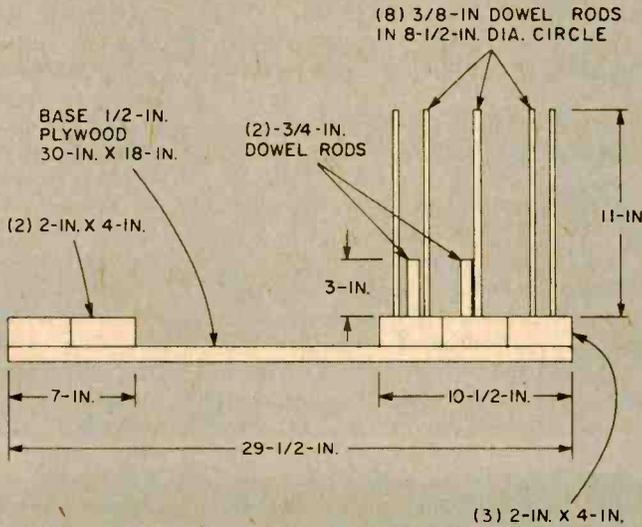
BASE 1/2-IN. PLYWOOD
30-IN. X 18-IN.



Top view of the base for the Tesla Coil, showing dimensions and placement of plywood mounting board, 2x4 planks, dowel rods for coil L1 and spark gap and the placement of the close-wound high voltage coil L2. Study this diagram before laying out the project.

High voltage coil L2 is made of a 1-pound spool of No. 24 enameled wire wound around a 26-inch length of PVC or plastic pipe, 3 1/2 inches in diameter. 4 1-inch angle brackets secure the coil to the 2x4 plank base which holds the dowels for L1.

Side view of the Tesla Coil base. The 8 11-inch dowel rods are the form around which the coil L1 is wound. The glass and foil sheets making up the discharge capacitor are stacked in the space between the two groups of 2x4s. The spark gap is supported by the two 3-inch dowel rods on base.

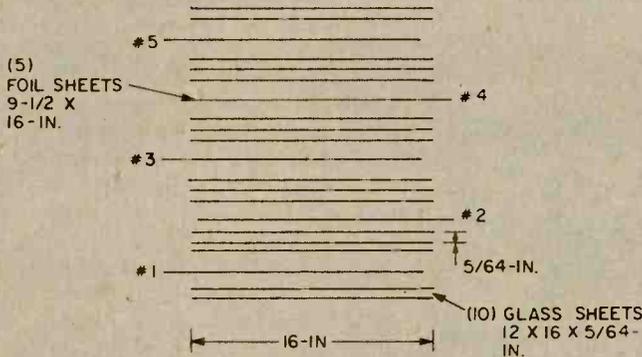


PARTS LIST FOR TESLA COIL

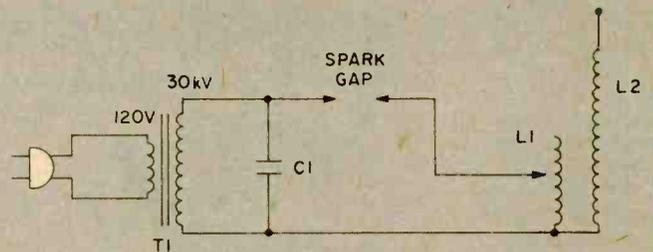
- Alligator clips—2, for use as movable leads
- Aluminum foil—5 sheets, 9 1/2 x 16-inch
- Angle brackets—4, 1-inch
- Dowel rods—8, 3/8 x 12-inch
- 2, 3/4 x 3-inch
- Glass—10 sheets, 12 x 16 x 5/64-inch
- Pipe—1 piece, 3 1/2-inch O.D., 26-inch long, PVC or plastic
- Transformer (T1)—Neon sign transformer, 30,000-volt (available used from sign companies)
- Wire—No. 24 enameled, 1 pound spool
- No. 10, insulated, 12 feet
- Misc.—Screws, nails, glue and other hardware as needed or desired.

FOIL SHEETS # 1, 3, 5
JOINED TOGETHER
TO FORM ONE
TERMINAL

FOIL SHEETS # 2, 4
JOINED TOGETHER
TO FORM ONE
TERMINAL



The discharge capacitor is made up of alternating glass and aluminum foil sheets. Sheets of glass must have a minimum thickness of 5/32-inch to prevent arcing. Thicker sheets of glass may be used, but overall efficiency of the Tesla Coil is reduced.



Circuit diagram for the Tesla Coil shows the great voltage differential between the two sides of transformer T1. The 30,000 volts AC leaving the high voltage terminals of the sign transformer is boosted further by coils L1 and L2, giving 100,000 VAC.

sult in arcing. Single glass sheets may be used if they are thick enough.

Glue a 2x4 plank across the plywood base with its edge against the sheets of the capacitor to hold them in place. Glue a second 2x4 next to the first. Mount the neon sign transfer on these two 2x4s securely.

The Spark Gap. Drill a small hole through each end of two 3/4-in. dowel rods that are about 3-in. long. Glue the dowels near the edge of the 2x4s on which L1 and L2 are mounted.

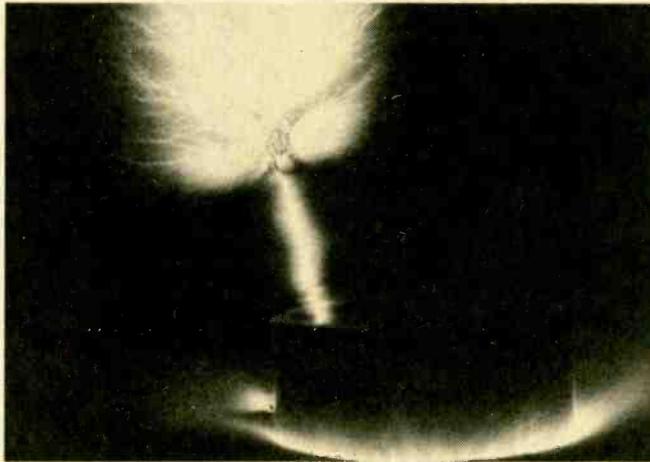
Wiring. Connect the ends of a piece of lamp cord to the primary terminals of the neon sign transformer and carefully tape them to prevent shock. Connect the free end of coil L1 to one of the high voltage terminals of the neon sign transformer.

Solder alligator clips to the ends of two short pieces of #14 insulated flexible wire and use them to connect the terminals of the capacitor to the high voltage terminals of the neon sign transformer output.

Attach a piece of #10 insulated wire to the high voltage terminal of the neon sign transformer which is not connected to L1. Remove the insulation from about 2-in. of the wire and insert it through the small hole in one of the 3/4-in. dowel rods. Take another piece of #10 wire and solder an alligator clip to the end. Clip this to the free end of L1. Remove the insulation from about 2-in. of the free end and insert it through the small hole in the other 3/4-in. dowel rod. Adjust the ends of the two wires between the dowel rods to form a gap of about 1/2-in.

Connect the wire from the bottom of the winding of L2 to the terminal of the capacitor to which L1 is attached and the wiring is finished.

Final Adjustments. Make a final check of all connections and wiring and plug the power cord into a wall outlet. There should be a fat, continuous spark



Dazzling lightning bolt effects result from a crumpled up piece of aluminum foil being attached to the high voltage output terminal of coil L2. While the amperage in this dramatic display is low, there are 100,000 volts here. CAREFUL!

across the 1/2 inch gap and nowhere else. If arcing occurs elsewhere, unplug the power cord and move the wiring or otherwise eliminate the cause before proceeding.

WARNING: Never touch anything on the unit unless the power cord is unplugged!

When the Tesla Coil is first placed in operation it should be possible to draw a short arc from the high voltage end of L2 with a piece of metal held on the end of a long insulated handle.

To get the most out of the Tesla Coil though, L1 and L2 should be tuned to the same frequency. To do this, remove a 1/2-in. long piece of insulation from each turn of L1 on the side nearest the spark gap. Don't make the bare spots on each turn exactly next to each other or the turns may short out. Then, *unplugging the power cord between adjustments*, move the alligator clip on the wire from the spark gap from one turn to the next until the arc from the high voltage end of L2 is longest. This will show that the two coils are tuned to the same frequency and maximum power is being transferred from L1 to L2. It should be possible to get nearly a 6-in. arc, indicating almost 100,000 volts.

Variations On the Coil. The Tesla Coil described here is pretty much a "bare-bones" affair, designed to be as simple and inexpensive to build as possible. It can be prettified if desired by adding porcelain insulators at the top and bottom of the high voltage coil and at the spark gap. This may also increase the efficiency somewhat, as may spraying coil L2 with an insulating compound.

If a higher output voltage is needed, the easiest way to achieve it is to increase the number of turns on L2, either by making it longer and using more wire or by using a smaller diameter wire. If this is done, more turns may have to be added to L1, and the number of tinfoil and glass sheets in C1 increased to keep the coils tuned to the same frequency. Thought should also be given to making the base board larger so the components may be spread out more to avoid arcing.

The properties of high voltage high frequency current may be shown in a number of experiments using the Tesla Coil. Tesla's dream of wireless power can be demonstrated by holding ordinary fluorescent tubes near coil L2 and watching them glow as though they were plugged into a wall outlet.

Another interesting experiment is to attach a small ball of crinkled tinfoil to the discharge end of the winding of L2. Corona discharges will shoot out from each of the pointed surfaces and extend purple lightning.

Still another demonstration is to make a small metal pinwheel in the shape of the letter "Z." Mount the center of the pinwheel on the discharge wire so it's free to turn, and turn on the juice. The pinwheel will revolve under the push of the ions.

The possibilities in the Tesla Coil are limited only by your imagination! Have fun!

This close-up view of the Tesla Coil shows the arrangement of the discharge capacitor, with its alternating sheets of glass and aluminum foil. Also shown is the wiring leading from the transformer T1 to the coils L1 and L2, and to the spark gap between the two 3-in. dowel rods.



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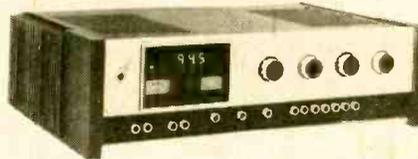


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When you build a speaker system, you sometimes find that it's easier to get good sound than a professional-looking cabinet. Here is a speaker that can give you both at a low price; and it's so easy to build you will need only a few hand tools. The night table speaker has one obvious use: as a set of stereo extension speakers in a bedroom, but the two-way woofer/tweeter system performs well enough to serve anywhere you need a set of speakers.

Speaker Components. A two-way system is a good compromise between the inadequate frequency response of most single cone speakers and the expense of a three-way set of crossovers and drivers. This one requires only two crossover components—a capacitor that acts as a high pass filter for the tweeter and an L-pad that permits you to balance the output of the tweeter to that of the woofer in any acoustical environment or location.

Fortunately, most current high-compliance acoustic suspension 8-inch woofers can be matched to the cubic vol-

ume of the enclosure described here for optimum bass performance. So if you already have some 8-inch woofers, there is a good chance that they will perform satisfactorily in nightstand cabinets. The speaker components list shows a choice of speakers, two systems that survived a test that included a number of other speakers.

For good performance at the lowest possible cost, the Varco woofer and CTS mid-tweeter are hard to beat. But if you want a system with deeper bass, somewhat smoother overall response and better high frequency dispersion, you should consider the Speakerlab kit. It is clearly the better system of the two, but at more than twice the price. To make the right choice you should consider the kind of use you'll make of the speakers as well as the size of your bank roll.

You may have to alter the diameter of the woofer hole slightly to fit the

woofer you use. The plans show this as 7 $\frac{3}{8}$ -inch about right for the Varco woofer, but for most 8-inch woofers the diameter should be 7 $\frac{1}{8}$ -inch. If you use the smaller diameter and later want to enlarge it, you can round off the outer edge of the cutout with a rasp or a piece of coarse sandpaper. Just knock off the front edge and the woofer will fit into the hole.

Putting It All Together. The speaker is built around, or into, a department store night table kit: Creative Furniture Kit #21114. This kit includes glue and nails with the pre-cut parts—everything you need except a hammer and screwdriver. For the inner speaker box you'll need some kind of saw to cut out the parts and a saber or keyhole saw to make the speaker holes.

You can use another brand of night table kit if you adjust the inner box dimensions to make it fit the night table. The speaker enclosure shown here has an internal volume of about 0.7 cubic feet. You can reduce the volume to about 0.5 cubic feet if necessary, but then you should use more sound damping material in a smaller box than is specified here. In fact, you may find that you get better sound from a smaller box by loosely filling it with polyester sound damping material. Don't overstuff the box by compressing the material; put it in gently.

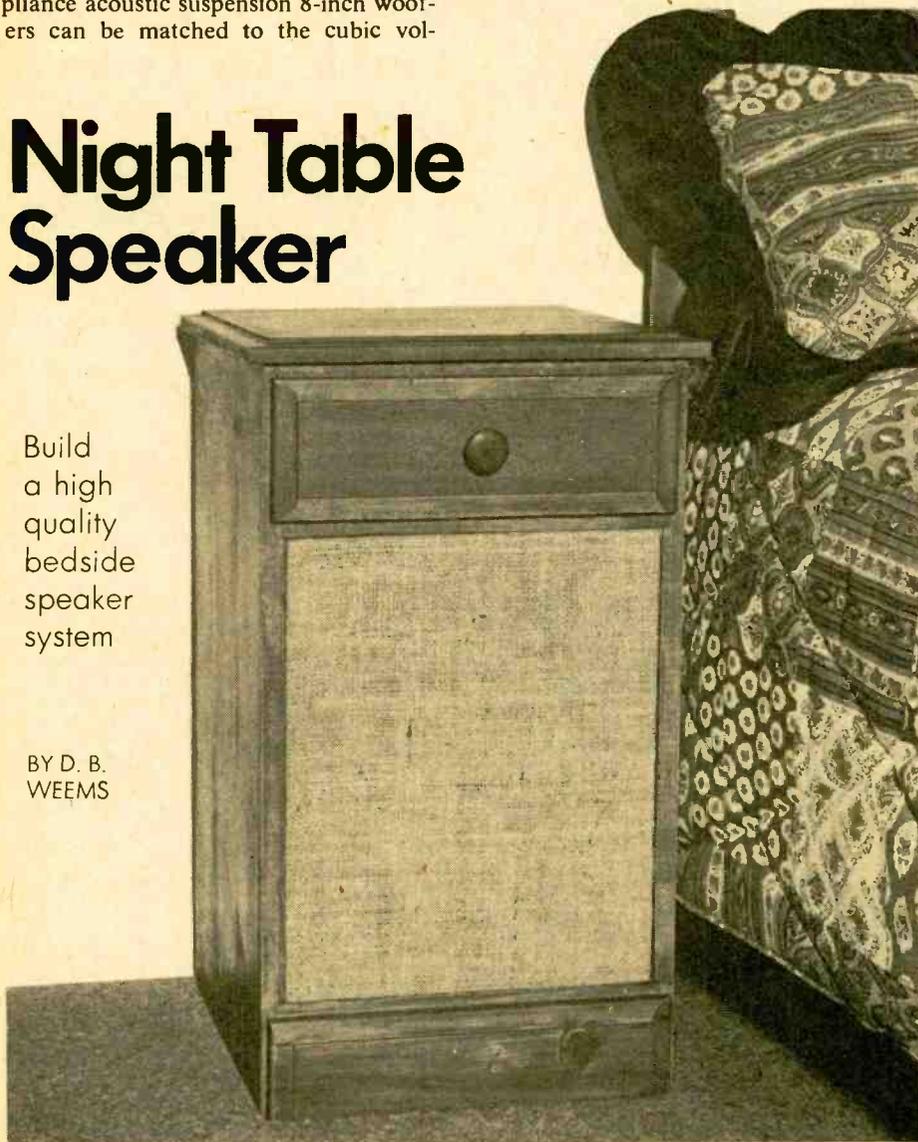
When you unpack the night table kit, it's a good idea to separate the three kinds of nails and two kinds of screws so you'll use the right ones at each step. The kit instruction sheet has one ambiguous drawing: the one showing how to nail together the frame parts. The $\frac{5}{8}$ -inch "berry box" nails should go through the parts at *right angles* to the tongues of the cleats. Someone at the store where I bought my kit had misinterpreted the drawing and put some nails through the frame in such a way that their heads showed from the outside of the finished cabinet of the display example. If you follow the printed instructions correctly, you will have no nail-heads that show. Remember that only finishing nails go through the exterior boards.

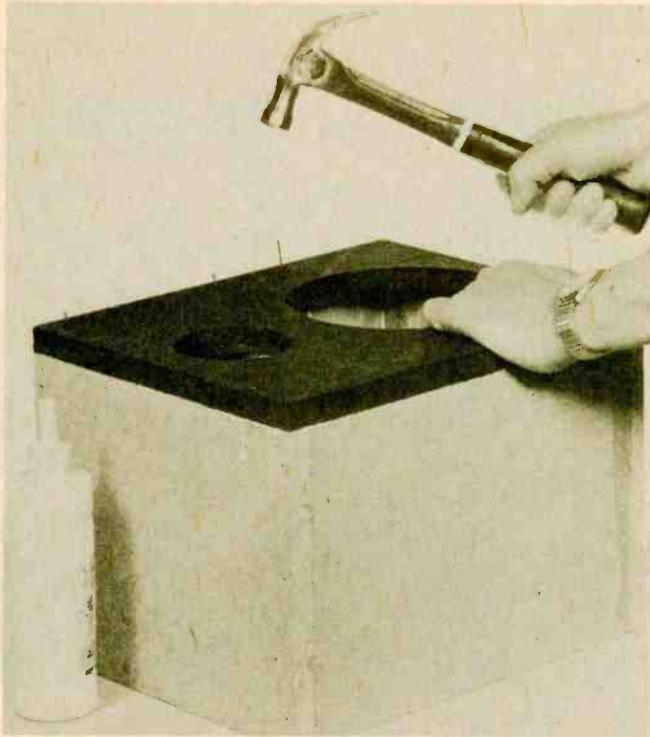
If possible, nail the frames together on a hard, flat surface to flatten any nail points that penetrate the rails. A smooth concrete floor is an ideal nailing support. When you assemble the cabinet, note that the top frame rests on the dadoed ends, its nails driven vertically through the frame members into the ends. Before you install the back panel you should cut a 3-inch by 4-inch rectangular opening in it to give access to the control board in the back of the inner box. Center this opening

Night Table Speaker

Build a high quality bedside speaker system

BY D. B. WEEMS





The inner speaker enclosure box must be assembled carefully. Make certain that all edges are square and flush.



Properly assembled, the speaker box should fit inside the opening in the night table with no space at sides.

between the left and right edges of the back with the lower edge of the opening located about 6 inches from the bottom of the panel.

Inner Speaker Enclosure. For the speaker box you can substitute $\frac{3}{4}$ -inch plywood for the particle board mentioned, but try to get pieces with no significant spaces between the layers. Cabinet shops often have left-over pieces of particle board or plywood that you can buy at reduced prices. They usually choose industrial grades of particle board with smaller particles and of denser construction than the cheaper grades.

Cut out the parts according to the plans and set them together to make

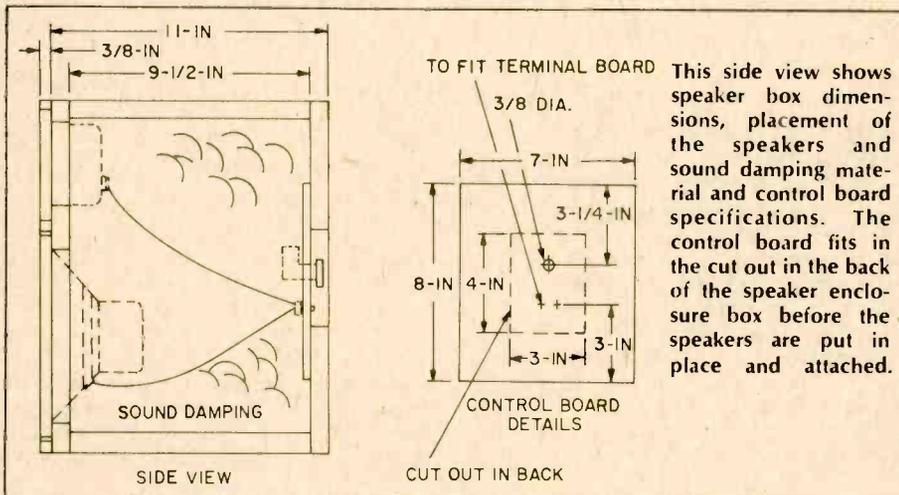
sure that the inner box will fit into the cabinet. Even better, tape or lightly nail the box together and try the fit. Then take the pieces apart and paint the speaker board flat black.

To assemble the box, apply a liberal coating of glue to the joining surfaces and nail the top and bottom pieces to the sides with 4-penny finishing nails. Then glue and nail on the prepared speaker board. After the glue sets, caulk the inner joints with latex or silicone rubber caulking compound.

Prepare the control board on $\frac{1}{4}$ -inch tempered hardboard according to the plan shown. Note that this step is unnecessary if you get the Speakerlab kit, which comes with its own control board

and pre-wired crossover. Drill a $\frac{3}{8}$ -inch hole for the L-pad and two $\frac{1}{4}$ -inch holes to match the position of the screws on the terminal board that you use. Install the L-pad with the hardware that came with it. Install the terminal board with glue and small screws or tacks. Connect a 12-uF non-polarized capacitor between the lug on one box terminal and pin #3 of the L-pad. Connect a wire from the other terminal to pin #1 of the L-pad. Then connect an 18-inch length of lamp cord to the box terminals for woofer leads and another 18-inch length to pins #1 and #2 of the L-pad for tweeter leads. Trace out the leads and mark the common leads with pieces of black tape, or check the lamp cord to see if one lead is coded by ribbing.

It's a good idea to check out the wiring before installing the terminal board. Turn off your amplifier and receiver before you connect or disconnect the speakers and turn the volume control all the way down. Connect the speakers to the proper leads, turn on the amplifier and listen to them at low volume. Turn up the volume just enough to see if the bass is coming from the woofer and the highs from the tweeter. Check to see if the L-pad controls the tweeter. If the wiring passes these tests, you can solder all the connections on the control board. Then glue and screw the board to the inside of the back, using silicone rubber glue.



This side view shows speaker box dimensions, placement of the speakers and sound damping material and control board specifications. The control board fits in the cut out in the back of the speaker enclosure box before the speakers are put in place and attached.

If you can leave it for a half day without moving it, you can use silicone rubber glue alone. But don't forget to place it on the back so that the speaker terminals will be accessible.

Line the side walls with a two-inch layer of damping material. You can fasten the material to the walls with tacks or blobs of glue. Glue and nail the back on the box. Caulk the inner joints around the back, working through the woofer hole. Then cover the back with a layer of damping material, inserted through the woofer hole.

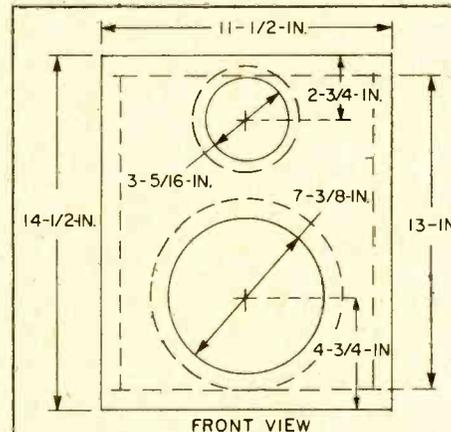
Bring the speaker leads out through the damping material and solder them to the proper speaker terminals. Run a bead of silicone rubber glue around the edge of the tweeter cut-out in the speaker board and set the tweeter in place. Follow the same procedure for the woofer. The silicone rubber automatically forms an air-tight gasket between the speakers and the board and holds them to the board. Don't use the speaker until the glue has set, preferably for a day or so.

Check the woofer's polarity by connecting a flashlight battery to the exterior terminals and watching the woofer cone movement on contact and break. When the battery is connected so that the woofer cone moves forward on contact, mark the terminal connected to the positive pole of the battery with a red dot or a plus mark. Do this for each speaker system you build to make phasing easier when you wire the speakers to your receiver.

Make up a grille frame by cutting a 4½-inch hole for the tweeter and an 8¾-inch hole for the woofer in a piece of ¾-inch plywood. Center the holes on the same points as the holes in the speaker board. Put the speaker box into the night table and check the fit of the grille frame. You may have to enlarge the woofer cutout to get the frame to go onto the box easily and still fit the space in the lower compartment of the night table. When it's right, paint the front of the frame flat black. Wrap some grille cloth around the frame and staple it to the rear surface.

Final Adjustments. Put the speakers in their permanent locations and connect them to your stereo system. Set the tone controls on your receiver to the flat position and turn the tweeter control down all the way. Then select a high quality program source and adjust the tweeter control up until the sound from the tweeter blends with that of the woofer.

Putting the final touches on the speaker cabinet. The grille cloth on the front gives the unit its decorative qualities. The Night Table Speaker is a handsome piece of furniture in its own right. If it's not sold in your local hardware or department store, order Kit #21114 from: Kerns RTF, Box 1187, 227 S.E. Byers, Pendleton, Oregon 97801.

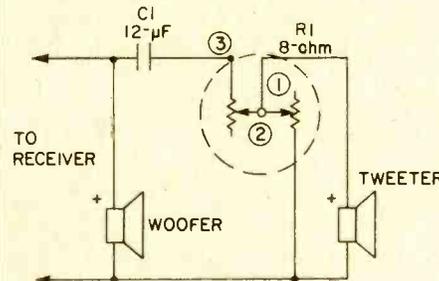


Front view of the speaker enclosure box, showing speaker placement and front panel dimensions. Hole diameters may vary slightly with speaker size.

PARTS LIST FOR SPEAKER BOX

- Particle Board
- 2—11½-in. x 14½-in. x ¾-in. Front and Back
- 2—9½-in. x 13-in. x ¾-in. Sides
- 2—9½-in. x 11½-in. x ¾-in. Top and Bottom
- Plywood
- 1—11½-in. x 14½-in. x ¾-in. Grille Frame
- Tempered Masonite
- 1—7-in. x 8-in. x ¼-in. Control Panel

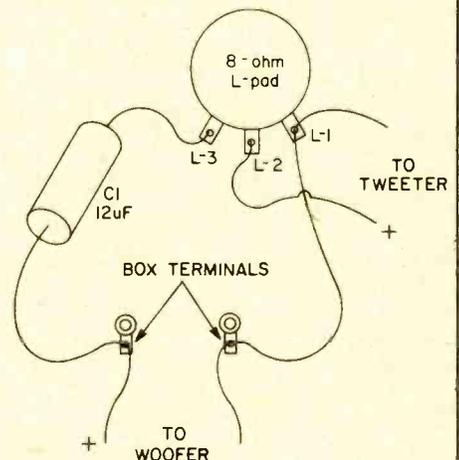
The speakers are housed in a Creative Furniture Kit #21114; this night table kit, or one very similar to it, is available at department or hardware stores in kit form, or assembled and unfinished.



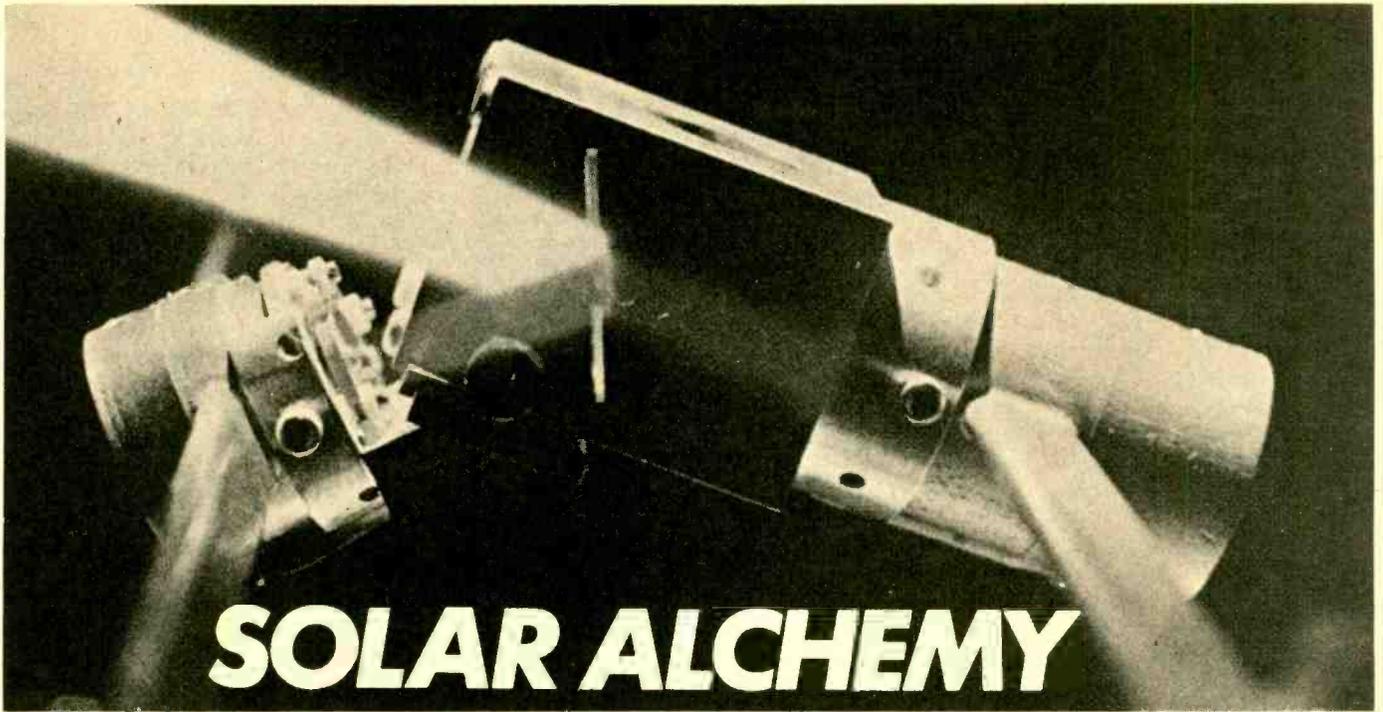
Crossover diagram for woofer and tweeter balancing. These components are included in the Speakerlab kit.

PARTS LIST FOR SPEAKERS

- 8-inch woofer (Varco-8 or equivalent)
- 3½-inch tweeter (CTS or equivalent)
- 8-ohm L-pad level control
- 12-µF non-polarized electrolytic capacitor OR: Speakerlab SLS kit, which includes woofer, tweeter and crossover components in one kit. From Speakerlab, Dept. BER, 735 Northlake, Seattle, WA 98103 or an electronics supply house stocking Speakerlab.



Component connections for the do-it-yourself version of the crossover circuit. Pay close attention to speaker polarity when wiring this balancing unit.



SOLAR ALCHEMY

Transmuting sunlight into electricity may be in everyone's energy future

BY T.J. BYERS

A GLEAMING, GLITTERING SATELLITE wings effortlessly through the voids of space performing a multitude of tasks. Meanwhile, a desert well pumps hundreds of gallons of water daily, changing an arid wasteland into an oasis. What do they have in common? They're both solar powered! Solar power by photovoltaic cells is a space-age technology which has come into its own on our planet.

Let's take a look at this workhorse of space, now established on terra firma, and see how it performs its magic.

Photoelectric Beginnings. We're not performing any new tricks here, just improving on some old ones. Although the photoelectric effect has been known for a century, it took the wizardry of solid state electronics to make it a practical reality. Many of the pioneers of electronics studied it, including such names as Davy and Edison. Albert Einstein gave it substance when he penned the photoelectric theory, for which he was awarded a Nobel Prize.

My first encounter with solar electricity came some twenty-five years ago, with the introduction of the selenium solar cell manufactured by International Rectifier, designated B2M. It was considered a breakthrough, in that it was within the budget of hobbyist and relatively efficient in use.

It powered more than one home-built transistor radio, despite its minute power capacity of 1/2-volt at 1-milli-ampere. Thumbing through the pages

of electronic periodicals of the time leads one to believe we were in a solar electricity boom, which was closer to the truth than many experimenters ever would have suspected.

Uncle Sam was also building solar powered projects. The race for space and the need to power earth orbiting satellites demanded a solar cell capable of supplying their needs in a hostile environment. Bell Laboratories obliged.

Bell, having just received the Nobel Prize for the invention of the transistor, was exploring the new technology of silicon semiconductors. Utilizing their vast knowledge of this budding science, they were able to produce the first silicon solar cell, the forerunner of today's photovoltaic cells.

Well, the success of solar generators in space is apparent. As bigger, more efficient cells become available, and oil supplies dwindle, terrestrial solar technology will branch off by itself, conjuring up its own special magic.

Solar Cell Theory. A solar cell consists of two types of silicon semiconductor material separated by a junction. Half the solar cell is made up of material designated type N. This semiconductor material tends to attract and hold electrons. The other half of the cell contains type P material, which has a surplus of electrons and is willing to give them over to the N substance. More on this later.

Think of the silicon atom as having four protuberances. It is the atom's

nature to want to hook up with other silicon atoms, rather than having its appendages flapping idly. These "arms" of the silicon atom are in reality electrons surrounding the silicon nucleus. The electrons don't swarm about the nucleus, as often depicted; instead, each electron occupies an energy shell. The closer to the atom's core the electron is located, the lower its energy and the more stable it is.

Each shell will accommodate a specific number of electrons, and each oscillates at its respective energy level. Atoms like the feeling of being complete. Should any shell lack the correct number of electrons, the atom is said to have a valence—a desire to complete the defective shell. The atoms at the junction, all having the exact number of electrons vibrating in each of its shells, are content to remain.

It's within this junction region that the sun will perform its magic.

This stable group of electrons in the junction remains at rest unless disturbed. Should an energy packet of sunlight (a photon) invade this clique, it's quite possible that it will be absorbed by one of the atoms. This boosts one of the electrons to a higher energy level or to a different, more remote shell. When this occurs, the electrons have a tendency to wander off, becoming lost.

These wayward electrons are attracted to their electron-hungry neighbors and collect in the N material. Here other free agents bustle about, satisfying

the atom's needs. The now deficient atom is bumped from the junction and migrates toward its P type cousin.

This state of events creates tension between the two factions. So much tension, in fact, that the dislodged electrons will do almost anything to get back to the warmth and security of the junction. But the laws of quantum, like a traffic cop, only allow for a one way trip. But there is a back door!

If a conductor is connected from the N to the P materials, it forms a tunnel for the electrons. The free electrons, accumulated in the N material, flee through the conductor.

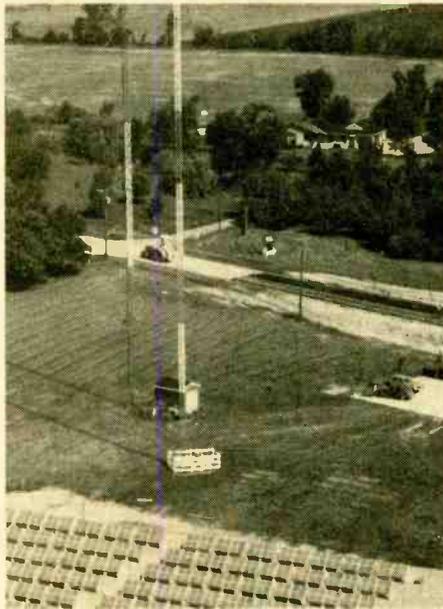
Since the pumped-up electron contains more energy than necessary to occupy its former position (shell), it can afford to be wasteful in its journey. Traveling through the conductor it meets certain amounts of resistance, from bumping into electrons and the like. This energy is released and can be put to useful work. It is current flow.

Once reunited with an atom, the happy couple try returning to that harmonious section, the junction.

Some Technical Considerations. What we've created is a wafer of silicon possessing a difference of potential (voltage). Theoretically, the voltage is 650 millivolts; in reality it doesn't exist. There are a number of reasons for this shortcoming voltage shortfall.

Let's return to the junction group. This lethargic group rests secure, with all shells occupied. But suppose an agitator were to disrupt their tranquility, something that would stir up a ruckus and send the atoms hurrying about. The "arms" (valence electrons) are now in a more excited state—a higher shell level—and tend to lose their grip on neighboring atoms, which are also rushing about busily.

However, the inciter doesn't arouse the electrons sufficiently to escape . . .



The transmitter of AM radio station WBNO in Bryan, Ohio is powered by an array of 33,600 cells producing 15 kilowatts.

just enough to create mass confusion; an arriving photon will be absorbed, as before. But instead of rushing to the N territory, there's a good chance the chaos will cause it to stumble to the opposite side—where it combines with migrating holes. The same is true for the holes, which mistakenly travel to the N section. Therefore, no current flow is generated by these backward electrons in transit.

This isn't true of all the atoms, but it does occur often enough to reduce the electrons available for useful work. The more excited the crowd becomes, the more likely it'll happen.

What could possibly cause this? Heat. Thermal agitation can and does disrupt the atoms' orderly state, creating enough havoc to reduce efficiency.

Impurities (other than those purposely introduced) can also add to the

reluctance of electrons to flow. Some atoms are more aggressive than others—in fact, some are downright explosive when it comes to matching-up with other atoms. Tenacious atoms, accidentally entering into the affair, grab the free electrons—never to release them. Hydrogen is such a culprit, as is oxygen.

It goes without saying that the more electrons dislodged and put to work for a given light level, the greater the efficiency of the unit. More electrons, more current produced.

With all these considerations, 460 millivolts is considered a practical figure per cell, with the open circuit voltage somewhat higher. Attempts are being made to increase this potential, thereby increasing efficiency.

Silicon Into Photocells. Now that you have a fair understanding of the internal workings, let's journey with a slab of silicon, observing its metamorphosis from sand to photon converter. A solar cell begins life as a silicate—much like common sand—not yet converting its energy into electrons.

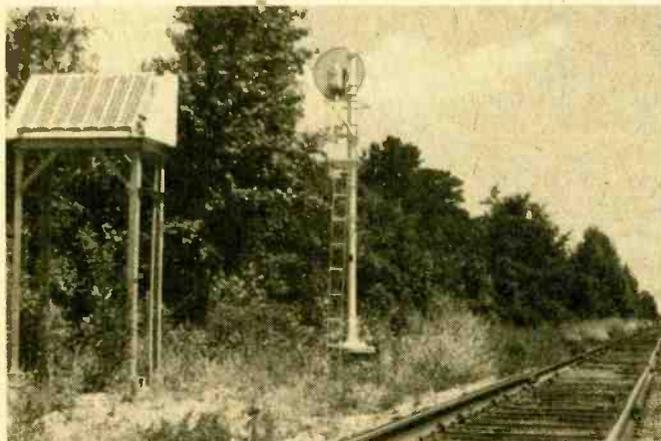
The silicon is refined (with a purity exceeding 99.99%), by being placed in a crucible and melted. A small amount of boron is added. Boron is an atom with five electrons in its outer shell, thus making it a donor (P type) substance; it will supply the free electrons.

A small, perfectly formed crystal, called a seed, is touched to the molten surface. The solution is held at its melting temperature of 1,420 degrees centigrade, controlled to within 2 degrees. The seed is rotated, inducing a counter rotation in the liquid. Individual atoms begin depositing on the seed, aligning themselves into a perfectly structured crystal, using the seed as a pattern.

Once the igot is finished, it's clamped into a saw, an abrasive cutter designed to slice the cylinder into wafers. Resembling a bread slicing machine, its multiple blades grind away, producing all wafers simultaneously. Unfortunately, this is an extremely wasteful process, rendering three-fourths of the crystal to dust.

Wafers 3 inches across and 16 mils thick reveal the shape of the completed cell. Sometimes the edges are cut, producing a square or rectangular unit. A freshly sliced disc carries saw blade marks on the surface. To remove the marks, the slab is subjected to chemical processing. A sodium hydroxide—the same as household lye—bath etches the blank to a smooth finish. The cell is now ready for processing.

The disc is submersed into a much



Solar power can eliminate the need for constant battery recharging in remote installations such as this railroad signal. A trickle charge can be maintained, thereby allowing the signal to function with minimum attention.

weaker 2% sodium hydroxide solution for approximately 30 minutes. This diluted bath doesn't etch the wafer's thickness as previously, but removes material from between the crystal structure. This characteristic of silicon leaves a plane of tetrahedrons. Incoming light is reflected off the sides of the pyramids, ricocheting its way to the junction. The tetrahedron allows the light to enter the cell, but reflects very little, thus eliminating the need for an anti-reflective coating. A sulfuric acid rinse neutralizes the alkaline etchant and cleanses the wafer. This process creates the type P semiconductor part of the cell.

The N type semiconductor is created through a diffusion process. Cells are placed in a quartz tube and the system purged with nitrogen. The temperature is raised to 850 degrees centigrade, and a measured amount of gaseous phosphorus acid is injected into the chamber. The phosphorus atoms disassociate and actually force themselves into the surface structure, displacing silicon atoms. With only three valence electrons, it produces the holes.

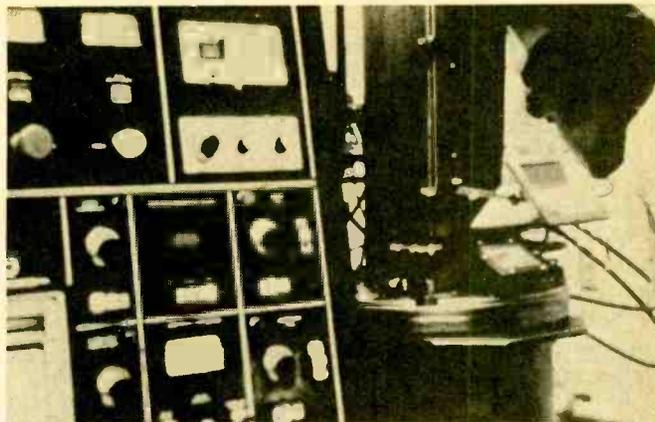
The junction is formed at the same time. It's within these seven angstroms the elite society will set up housekeeping; the remaining wafer thickness is largely for physical support. (An angstrom is equal to 10^{-4} microns. A micron is one-millionth of a meter!)

Two discs are placed back to back during the procedure. This avoids forming a junction on both sides of one cell.

Our silicon slab is now a bona fide photovoltaic cell. All that's necessary is to remove the free electrons and put them to work. The front surface, the one sporting the junction, is printed with a network of thin lines, all interconnecting with one another.

Here the manufacturer must make a compromise. The grid can be silk-screened, a simple process producing thick heavy lines, or extremely thin lines can be made by vacuum depositing metal through a mask. Obviously, the wider grid lines block photons from

A technician monitoring photocell production peers into the furnace where the cylinders are being formed. Furnace temperature is kept at more than 1400 degrees Celsius throughout the production process.



reaching the junction, while the thinner vacuum formed lines require a larger equipment investment and higher manufacturing cost to produce.

This is a tough decision, because the grid lines must be of sufficient quantity—giving the electrons a short path to travel (or else they get chummy and combine with an atom). This means the more numerous the lines, the more photons that are blocked.

The exception is space-destined cells. Here efficiency is paramount and cost secondary. There's another variation in aerospace solar cells—wafer thickness. Weight is critical in space vehicles, so the silicon is only about 4 to 6 mils thick, making them extremely fragile. A conductive coating is applied to the back to complete the circuit.

Solar Cells Galore. Silicon solar cells are the most popular and least expensive. That's not to say nothing's new under the sun—there's plenty happening!

Silicon cells suffer two drawbacks: high cost/power ratio (watts per dollar) and mediocre efficiency. Research is traveling a variety of routes seeking a solution to this.

The efficiency of a typical silicon unit is around 11%. If this percentage were raised, the price per watt could be reduced. But, atoms are very selective about the kind of photons they'll absorb. Silicon has a preference for long,

low energy wavelengths. This affinity for light in the red to infrared spectrum limits the theoretical efficiency to under 20%. Gallium arsenide, on the other hand, prefers high energy, high frequency photons.

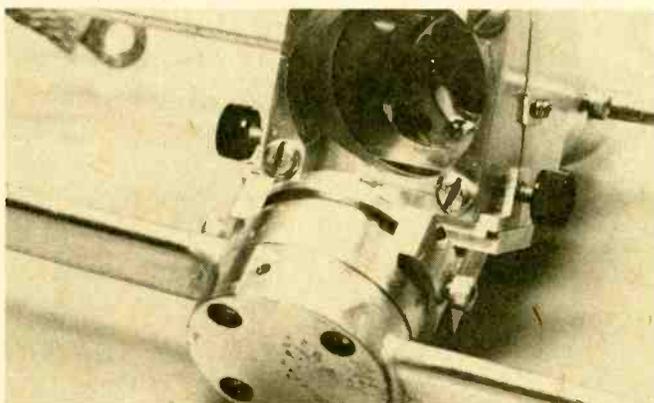
Gallium arsenide technology is newer and not as well developed as silicon, but it promises greater rewards. Cell efficiency presently exceeds 20%—a sizeable difference. On a one-to-one basis, it would require about twice the surface area of silicon to equal the power of gallium. Manufacturers are striving for 30% conversion, a figure they say is already within reach.

Let's examine a gallium arsenide solar generator. Again we have two semiconductor materials—a substrate of N doped GaAs (the chemical shorthand for gallium arsenide) and P type GaAs—with the junction sandwiched between.

An overcoat of aluminum gallium arsenide (AlGaAs) about 10 microns thick is vacuum deposited over the P type semiconductor, forming one electrical contact. Photons pass through the AlGaAs and strike the junction region, dislodging electrons. The free electrons collect in the N type material, where they are removed and allowed to flow.

A recent approach to increasing the efficiency of AlGaAs is to stack them with silicon cells. An AlGaAs cell is placed on top of a silicon unit. The entering sunlight strikes the GaAs junction, which promptly absorbs the high frequency photons; the low energy wavelengths pass through and are absorbed by the silicon wafer. The overall performance 11% silicon and 17% GaAs approaches the 30% mark. Not a bad gain in efficiency.

Another way to enhance cell output is multiplying the available light; this is usually accomplished by focusing the sun's radiation with parabolic reflectors. A concentration of 20 suns isn't uncommon, with technology sending that figure soaring up to 1000! The cells are specially manufactured to be mounted



Close-up of Varian's tandem cell. This configuration, where two cells are stacked one above the other, gives it an efficiency rating that approaches 30%. The tandem arrangement may be the wave of the future in solar cell current generation.

onto a heatsink. The grid lines are thinner and more numerous, since they have to handle more electrons. It's sort of like adding freeways to eliminate traffic congestion.

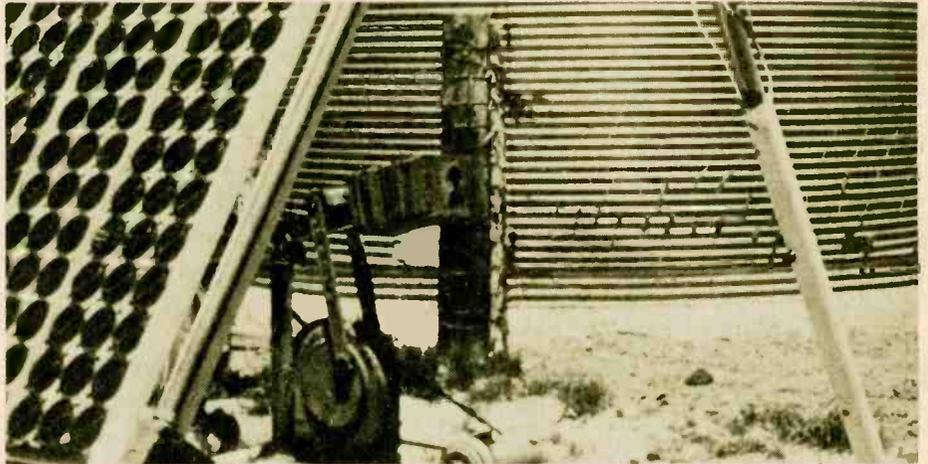
Gallium arsenide cells are especially suited for concentrator setups. They'll operate at 200 degrees centigrade with no heatsink and little loss of efficiency. An equivalent silicon unit drops appreciably above 50 degrees centigrade. By water cooling the AlGaAs cell and concentrating the light to 1000 suns, a single cell 1/3-inch in diameter is capable of producing 10 watts of power!

Of course, this system must be able to track the sun as it journeys across the heavens, but considering the gains it's well worth it. Tracking capability in any solar collector will increase its performance by 40%.

Bargain Cells. Some researchers are taking the opposite road: reducing manufacturing cost and settling for less efficiency. The cost of growing and cutting crystal ingots is astronomical in comparison to subsequent steps, since over half is lost to dust. Let's look at one manufacturer's solution.

First, a ceramic substrate is coated with carbon. This enables the molten silicon to adhere. The substrate is dipped and the resulting silicon layer exhibits a grain structure which is larger than the thickness of the layer. But, unlike the pyramids of the crystal, it appears that whiskers are growing on the surface when viewed under a microscope. These whiskers add to the surface area available to light.

The ceramic backing is laced with slots, permitting access to the reverse side of the semiconductor. The semiconductor is now processed in the usual manner previously described.



This water pump, miles from the nearest power source, draws its electrical power from a bank of solar cells. Solar powered pumps such as this one can make the desert bloom, reclaiming arid wasteland and transforming it into arable, productive farm or grazing land. And solar technology is rapidly becoming competitive with traditional sources.

An advantage of this process is its ability to be manufactured in long strips. The strip is passed over molten silicon, a procedure similar to flow soldering. This greatly reduces the silicon loss, cutting costs. The process is also easily adapted to automated assembly and manufacture.

There are numerous approaches, using a variety of materials—including plastics and removable backing. The silicon doping impurities also vary widely with application.

Here's an interesting approach. Two strands of silicon are touched to the surface of molten silicon. Capillary action sucks up the liquid, filling the gap, which can be as wide as 40 mm. This does away with the need for support backing, since it's rigid enough.

Still others are trying the thin film approach. Here we have low cost and low efficiency (5%)—hopefully these

drawbacks will be offset by improved cost effectiveness. The candidate here is cadmium sulfide coupled with copper sulfide on thin film.

P doped copper sulfide is applied to an aluminum backing, sprayed or dipped. To this a thin layer of N type cadmium sulfide is vacuum deposited—about 20 microns—forming the junction. Since the thicknesses involved are on the order of microns, very little material is used (and consequently little is wasted). A transparent conductive grid is applied over the N material and protected by a Mylar covering.

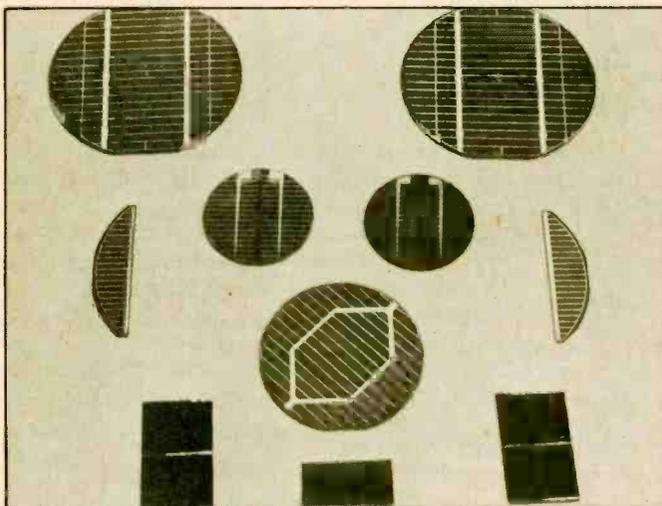
The material cost is low, as is the number of manufacturing steps involved. But such a design must maintain a greater surface area.

A more recently announced development incorporates liquid as the energy converter. Although details are sketchy at the time of this writing, they read like this: dust-sized particles of silicon are placed in transparent capillary tubes, which are filled with an electrolytic generating fluid.

Sunlight striking the silicon generates electricity, which in turn breaks the electrolyte down into its components, probably something like hydrogen bromide and water.

The decomposed matter is transferred to a fuel cell (presumably with a pumping system) where, upon recombination, electricity is generated. I suspect the fuel cell is similar in design to the type developed for the Apollo missions. The electrolyte is then recycled, making the process continuous.

Well, that wraps up our jaunt through solar technology. I'm sure you'll agree that the future is looking bright. ■



Photovoltaic cell varieties. The larger discs are high output cells, the smaller discs and crescents have a lower output. Rectangles are highly sophisticated cells destined for use in space exploration.

NO MATTER WHAT TIME OF YEAR it may be, from the arctic blasts of a Buffalo winter to the swelter of St. Louis in August, you've probably had the unfortunate experience of having your car's engine overheat. Whether it's due to a malfunctioning water pump, a broken fan belt, frozen coolant, or a leaky radiator hose, the bottom line is that it's one All-American pain in the neck when it happens. Regular and thorough automotive maintenance will prevent this most of the time. However, when the unexpected happens, a temperature gauge can forewarn you of impending disaster—and possible engine damage, *before* the engine overheats.

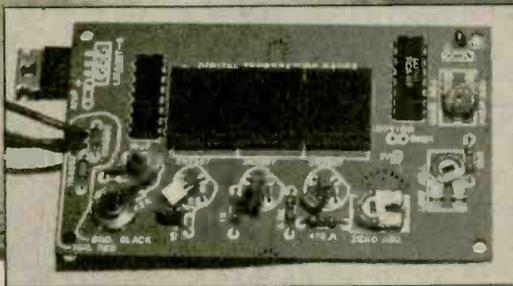
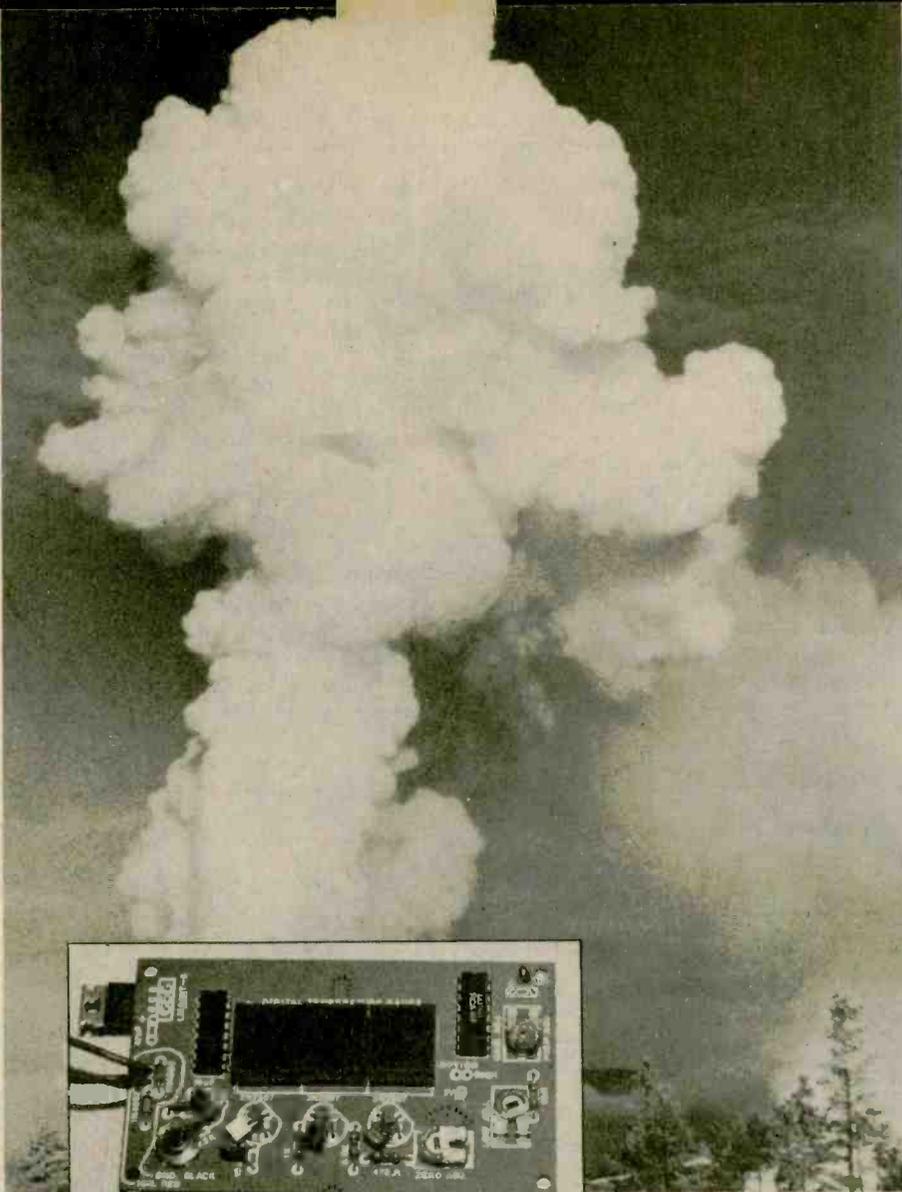
It's unfortunate that most car manufacturers do not see fit to offer gauge packages (except at outrageous optional prices) on their vehicles. The few that do, offer mostly uncalibrated units which are no more helpful than a dummy light—they tell you only that you're *in* trouble, not that you're *about* to be. The following is our answer to this dilemma, the second in a series of digital automotive (and marine) instrumentation feature articles.

Features. This relatively simple and inexpensive temperature gauge offers three-place digital readout of Fahrenheit temperatures in the car's engine from a low of 0° to a high of about 250° (well above where your engine is likely to start melting). About the only type of engine with which this gauge may not work would be the small, 4-cylinder diesels now found in Volkswagens and some other imports. These engines normally operate at higher temperatures than gasoline engines, and may have an effective heat range outside the limits of this gauge. Check with your dealer or manufacturer for the nominal operating temperatures of your car's engine just to make sure.

Use of our gauge will not interfere with factory-installed gauges or dummy lights, and we suggest that they be retained as a back-up system. In addition, our gauge is easy on energy, with a maximum current consumption of 160 mA or less.

Circuit Operation. Spike protection (spikes result from turning inductive devices on and off) for the LM340T-5 (U1) is provided by capacitor C1 and diodes D1 and D2. Transients ("noise") on the 5-volt line are suppressed by capacitor C2 and the LM340T-5.

A positive potential between pins 11 (+) and 10 (-) of U2 is converted by the CA3162E into a BCD (binary coded decimal) output which reflects that difference. The CA3161E is the control element that actuates the 7-segment display. For an example of a



Dashboard Digital Temperature Gauge

This accurate gauge can keep your car from going off like Old Faithful BY FRED L. YOUNG SR. AND FRED L. YOUNG JR.

typical cycle of switching action, assume that the display is displaying "2." This is the 1's place or least significant digit. The instant pin 5 activates the PNP switching transistor of the least significant digit, the BCD for "2" is generated in the CA3162E. The BCD code leaves pins 2, 1, 15, and 16, and enters pins 7, 1, 2, and 6 of the CA3161E decoder driver (U3). The CA3161E then takes that BCD code and activates (lights) those segments of

the 7-segment display forming a "2." In reality, an optical illusion is being created for the eye. At any given time, only one display (digit) is actually on. Because of the brain's image retention of the eye's sensing capacity, all displays appear to be on simultaneously. The same cyclic sequence occurs with the two remaining displays.

As a final note on operations, we should touch on the matter of cyclic conversions or comparisons made each

second (note the point marked OPTION on the schematic). With the OPTION point left disconnected, the comparison (or display update rate) is set at 4 Hz. We feel that this is probably the most pleasing to the eye and the least distracting. With the OPTION point grounded, the comparison rate goes up to 96 Hz. The result of this is that the display will appear to be unstable as the numbers fluctuate at the more rapid rate. As a result, and depending upon where in the line of the driver's vision the gauge is mounted, it may tend to be a distraction. This is the common bugaboo with all digital gauges, especially tachometers and speedometers, which can undergo rapid changes in readout as data

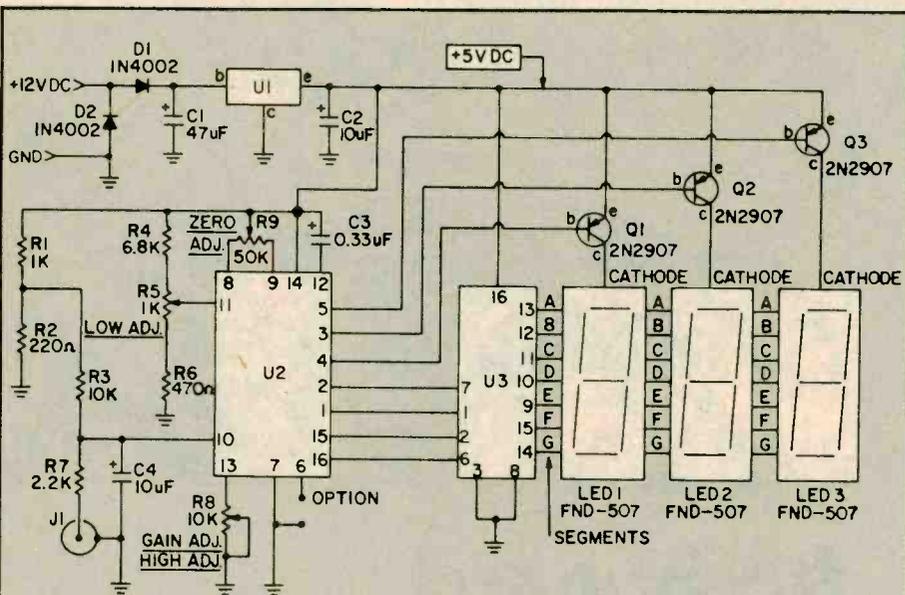
input from the engine changes. Experiment yourself, but you'll probably agree that the 4 Hz rate is decidedly the most attractive of the two choices.

Sensing Probe Operation. The response to temperature change of a silicon diode is linear as it reflects a rise or fall. As the temperature rises across the diode's PN junction, the forward voltage developed across it drops. This would make it seem that diodes could be interchanged with no effect on readings. Unfortunately, such is not the case. While the rise and fall responses to temperature changes are for all practical purposes uniformly linear, the *base starting points are not*. Because of this, *calibration must be repeated* if the sensing probe diode is replaced.

Note that resistors R1 and R2 form a voltage divider network that has a one-volt (approximate) drop across R2. The one-volt is dropped across R3 and R7 in series with the temperature-sensing diode (the probe). The latter two resistors limit the current to the temperature-sensing diode. The forward voltage drop that is developed across the temperature-sensing diode is now applied to the negative input terminal, pin 10 of U2. As the temperature rises, the forward voltage drops linearly. The inversion resulting from the rise or fall is compensated for by applying the forward voltage to the negative input, which is pin 10 of U2.

Let's illustrate the action described in the preceding paragraph. Assume for each degree of Fahrenheit change there is a corresponding 1.0 mV change. Assume, also, that at 32°F, there is a 0.55-volt or 550 mV forward voltage drop. The CA3162E (U2) "looks" at the positive input (pin 11) and the negative input (pin 10), and then generates a BCD code reflecting that difference, transmitting this to the display by means of the CA3161E (U3). If the positive input, pin 11, is 32 mV greater than the negative input, pin 10, or reads a total of 582 mV, then the CA3162E will "see" a difference of 32 mV and the 7-segment displays will display "032." As the temperature increases, the difference becomes wider. At 212°F, the voltage at the negative input would be 370 mV. Therefore, the voltage difference between pin 11 (positive) and pin 10 (negative) would be 212 (582 mV - 370 mV = 212°F). Since the tolerances of diodes tend to vary somewhat, we have only stated an approximate maximum reading range for our temperature gauge. The temperature at which your gauge will cease to function linearly will be determined by the quality of the individual diode used in the construction of the probe.

Assembly. After etching your PC board, (or receiving one from Digital World) check the finished product for foil bridges and other imperfections which might create difficulty during assembly and calibration. Leaving installation of U2 and U3 for later, install all other components on the board, following the component placement guide. Be sure to observe polarity with respect to diodes, electrolytic and tantalum capacitors and the LED displays. Make sure that when J1 is installed, the outer shell is given a good ground by soldering it to the large foil area on the board.



PARTS LIST FOR DIGITAL TEMPERATURE GAUGE

- C1—47-μF, 25-VDC electrolytic capacitor
- C2, C4—10-μF, 16-VDC tantalum capacitor
- C3—0.33-μF, 35-VDC tantalum capacitor
- D1, D2, D3—1N4002 diode
- J1—RCA-type phono jack
- LED1, 2, 3—FND-507 7-segment, common cathode display
- P1—RCA-type phono plug
- Q1, Q2, Q3—2N2097 PNP transistor
- Note: All resistors rated 1/4-watt, 5% tolerance unless noted otherwise.
- R1—1,000-ohms
- R2—220-ohms
- R3—10,000-ohms
- R4—6,800-ohms
- R5—1,000-ohm trimmer potentiometer
- R6—470-ohms

- R7—2,200-ohms (see note below)
- R8—10,000-ohm trimmer potentiometer
- R9—50,000-ohm trimmer potentiometer
- U1—LM340T-5 voltage regulator integrated circuit
- U2—CA3162E dual slope/dual speed BCD encoder
- U3—CA3161E BCD decoder/display driver
- Misc.—5 to 10-foot length of RG58A/U coaxial cable, epoxy glue, red plexiglass stock, solder, spacers, hookup wire, replacement intake manifold bolt for probe assembly (obtainable from your new car dealer), etc.
- Note: During the calibration procedure, it may be impossible to calibrate for the high end unless the value of R7 is lowered to 1,500-ohms, or even 1,000-ohms. Select the highest value of resistance for R7 that allows full scale calibration (212°F).

A pre-etched, drilled and labeled PC board for the Digital Temperature Gauge (\$6.00) and a complete parts kit, including PC board (\$28.50), but not including plexiglass screen, is available from: Digital World, Inc., P.O. Box 5508, Augusta, GA 30906. Allow 4-6 weeks for delivery. No C.O.D.s or foreign orders please.

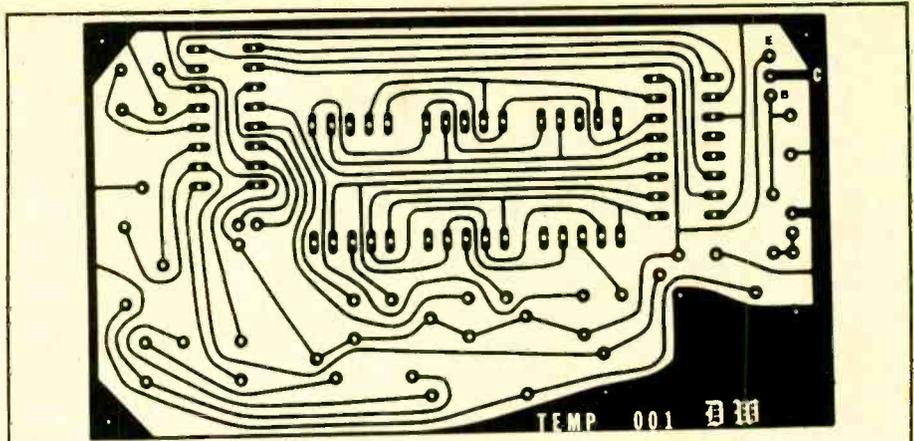
We strongly suggest that you make use of IC sockets when installing U2 and U3. These two chips are highly sensitive to static electrical damage caused by handling without insulated tweezers. In addition, stray AC from the tip of your soldering iron (not to mention excessive heat) can also cause irreparable damage to the chips.

With all components installed, make a final check of the board against the component layout diagram as a precaution. If the final check is positive, proceed to wire in the 2 leads for the 12-volt power source. The unit is now ready for calibration.

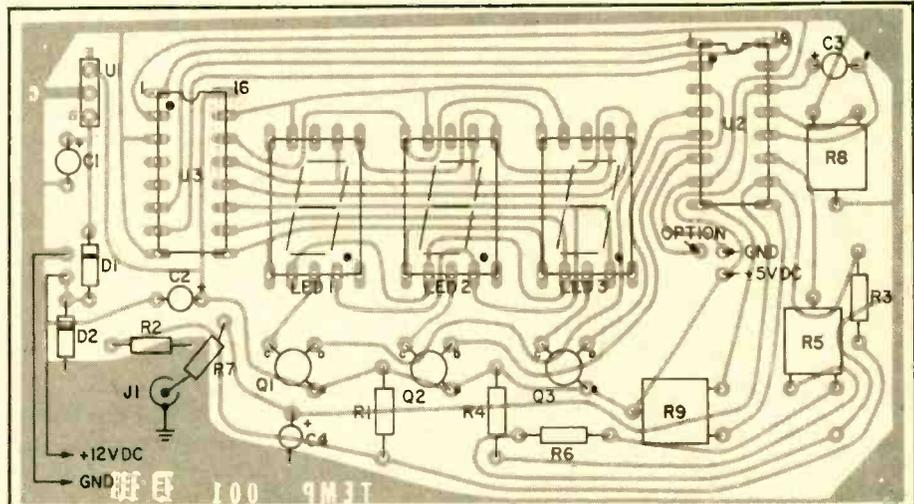
Probe Assembly. As mentioned earlier, the probe itself is simply a 1N4002 diode which is wired across one end of a length of RG58A/U coaxial cable. Check the diagram to obtain proper diode polarity and for details on its construction. Be certain that you have a length of cable that is sufficient to pass through the firewall and reach the point at which you are planning to install the gauge. You should avoid having to splice the coax at any point to add length. Moisture entering under the outer insulator of the coax will cause rapid deterioration and result in inaccurate or erratic temperature readings from the gauge.

Obtain a new intake manifold bolt (or stud) from your automotive dealer or parts supply house. Placing the bolt carefully in a bench vise (take care not to damage the threads), drill a 5/16-inch diameter hole down the center of the bolt, stopping 1/8-inch from the bottom. Solder the diode's anode to the center conductor, and the cathode to the braided shield (see diagram). Now, mix the epoxy that will be used to anchor the probe in the hole. Use of a slow-setting type will allow you more time in setting the depth of the probe.

Now attach one terminal of an ohmmeter to both the shield and the center conductor of the coax at the free (gauge) end. Ground the other ohmmeter terminal to the bolt. You will use the ohmmeter to make certain that the sol-



Here is the full-scale etching template for the printed circuit board. See the parts list for ordering information on a ready-to-go board if you don't etch your own.

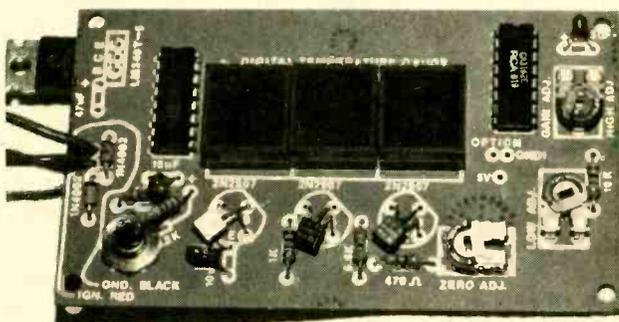


Follow this component layout guide when assembling the PC board. Note that in this diagram, U1 is installed on top of the board. Depending upon your space requirements, it can go on top or bottom, but be careful not to reverse the pin connections.

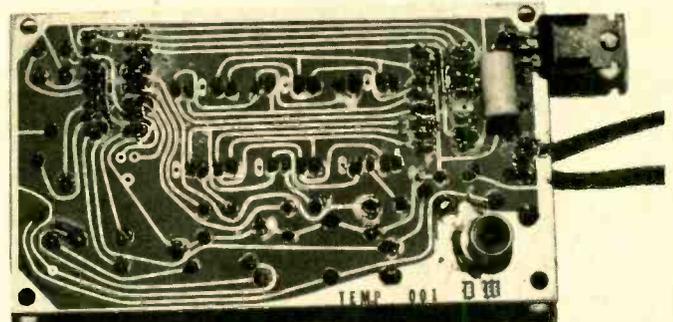
dered diode connections do not contact the sides of the bolt hole, creating an unwanted short.

Fill the hole halfway with the epoxy mixture. Some of this will be forced out as the probe is inserted, but it can be wiped away easily. Force the probe all the way in until it stops. At this point, the ohmmeter should be show-

ing a completed circuit. Gently begin withdrawing the probe until the ohmmeter shows that the circuit is broken. Secure the coax in this position until the epoxy sets, continuing to check to see that there is no reading on the ohmmeter. Let the assembly dry for at least 24-hours before checking once again to see that the probe is not in contact with



This photo shows the completed board ready for installation in a car. Jack J1 may be reversed for flush mounting on the dash.



The foil side of the completed board shows U1 mounted from the underside. If pins are reversed, U2 and U3 will be ruined.

the bolt. If the process is successful, you may now proceed with the installation of the probe on the manifold.

If, due to the design of your car's manifold (or a reluctance on your part to remove a manifold bolt) you do not wish to follow the recommended installation procedure, we can suggest an alternative. Simply secure the probe to the side of the engine block with the epoxy. Prepare the area first with a thorough cleansing before applying the epoxy. Apply a coat of epoxy sufficient to coat the metal entirely within the intended installation area. Allow this to set until very tacky. Next, observing the same anti-short procedures as described above, embed the diode in the semi-hard epoxy, and cover with more epoxy to completely enclose the probe and coax end in it.

While this method is obviously the easier of the two, you will experience some loss of sensitivity and accuracy (we estimate somewhere between 5 and 10%, depending upon how close you can get the diode to the engine wall

without creating electrical contact). Whether you accept the trade-off between accuracy and ease of installation is up to you, and should be determined primarily by your degree of mechanical expertise. If you doubt your ability to remove, modify and re-install the manifold bolt, have someone else do it for you, or else use the external attachment.

Troubleshooting. As an initial check prior to calibration, apply a DC voltage of between 10 and 16-volts (preferably 13.8-VDC) to the power input of the gauge, after having connected the probe to the gauge via J1. You should obtain some reading on the displays, and all three should be lit. If this is not the case, and all displays are unlit, check the connections to the power source, and check to see that R9's wiper is centered. Furthermore, check to see that all components have been installed properly on the board with respect to polarity, especially D1 and D2. Improper orientation here will prevent power from reaching the rest of the circuit. If these steps fail to alleviate the problem, make a physical inspection of the printed circuit board for foil or solder bridges that might be creating shorts. Before removing any solder bridges in and around the ICs, remove the ICs from their sockets to avoid heat and AC current damage.

Calibration. Assuming that all bugs have been removed from the circuitry by means of the troubleshooting section (or by virtue of your expertise having obviated the need for troubleshooting in the first place), apply power to the circuit and begin the calibration procedures. At this point, we should note that the accuracy of your gauge will be determined by the degree of calibration exactness that you apply here. Take your time.

To zero the gauge (as you would with a mechanical meter movement), temporarily ground pins 10 and 11 of U2 to circuit ground, and adjust the wiper of R9 very slowly until all displays read zero. Disconnect the temporary ground on U2. Center the wiper of R8, and place the probe in ice water for a full five minutes (to compensate for thermal inertia). At the end of five minutes, slowly adjust R5 until the display is reading "032."

Next, immerse the probe in boiling water for five minutes, and at the end of this time, adjust R8 for a reading of "212." Of course, this adjustment is made on the basis of the sea level boiling point of water. Check the boiling point for your locality's altitude, and

adjust R8 accordingly. Repeat the low and high end adjustments at least once more to compensate for any interaction among the two adjustments. Again, patience here will pay off in a more accurately operating instrument.

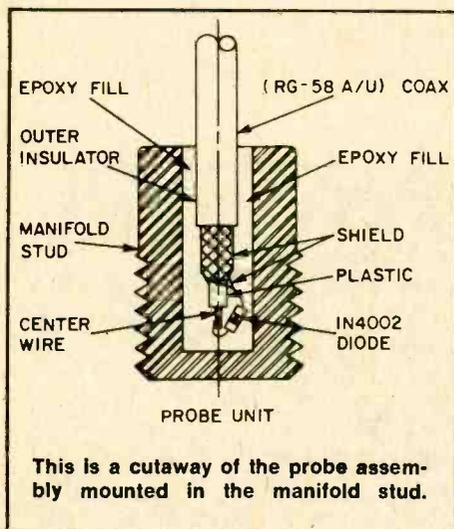
Installation. Select an appropriate position for the gauge, and install it by whatever convenient means suits your car and the position you have selected. Use a red plexiglass screen across the opening in the cutout for the displays. Red, although it probably doesn't seem logical at first thought, will offer the highest contrast display background.

Next, install the modified manifold bolt (containing the probe) on the cylinder head. Obviously, in order to protect the coax at this point, it should be coiled into a tight loop to avoid putting undue stress on it during rotation. After the bolt has been properly re-torqued, route the coax directly away from the engine towards the fender. This will avoid close contact with hot engine parts and high-voltage ignition

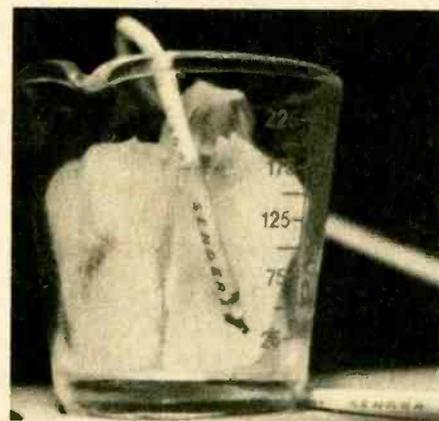
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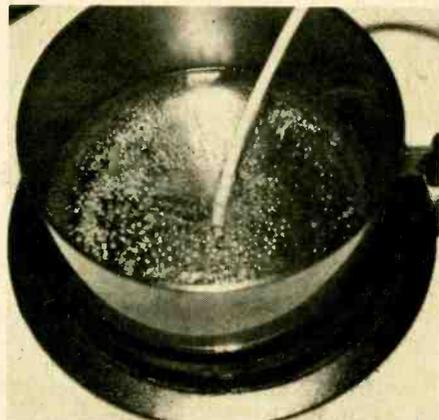
Here's a closeup of the probe assembly. Anode is soldered to the coax center wire.



This is a cutaway of the probe assembly mounted in the manifold stud.



Use a setup like this for the low end calibration of the temperature gauge. See text.



Allow 5 minutes in boiling water to compensate for thermal inertia in the diode.

E/E CHECKS OUT THE...

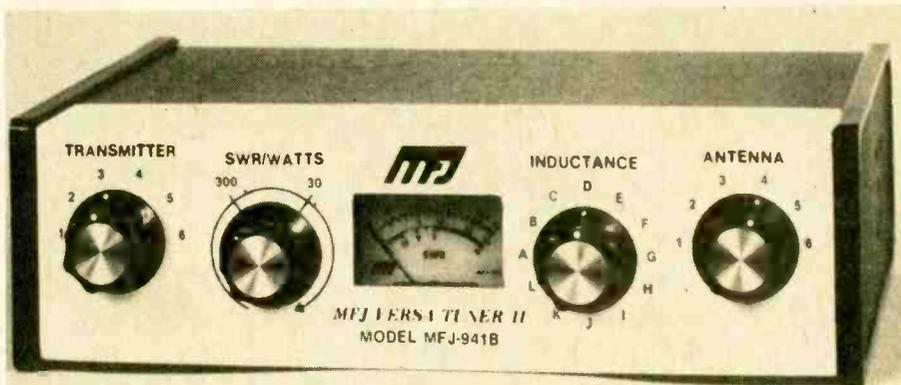
THE MFJ VERSA TUNER II, Model MFJ-941B is one of those low-cost products that surprises the buyer with the number of features it incorporates and the quality of manufacture it displays. At \$79.95 the 941B is a virtually irresistible bargain for any ham that is looking for a medium-power antenna tuner for his shack.

Features Galore. It's hard to tell where to start in listing the possibilities this little tuner offers. It'll handle 300-watts plus output from the transmitter; it'll match coax fed or balanced line fed antennas, since it incorporates a 1:4 balun transformer. The 941B will read out either Standing Wave Ratio (SWR) or power output in two ranges, 30-watts or 300-watts. There's an antenna selector switch (mounted on the rear panel) which allows switching to one of the two coax fed antennas (direct or through the tuner) and either a balanced line antenna or random wire antenna. There is also a bypass position. It will tune 160-meters, too.

Testing Results. We put this tuner through its paces in a number of situations, including one operating location we hope you'll never have to tolerate. With many different types of standard antennas—from dipole to inverted vee to beam it worked fine. Using it with a random length long-wire—as long as it's not an impossible length—produced excellent results, and use in a mobile installation to tune out reactance in a mobile whip from inside the car was a delight. Even in one of our editors' home locations (a small apartment in a forty-five story building) the 941B worked out well. It seemed immune to the RF feedback that plagues the other equipment (and some other tuners) in that location—a result of poor grounding and an antenna that hangs no more than six feet away from the rig.

Happy Conclusion. Certainly excellent design plays a major role in the success of this tuner, but high-quality construction also claims its share. The 941B uses a large-diameter air-wound inductor, ceramic switches throughout, standard coax sockets and binding posts, and high capacity (1000-volt) capacitors. The unit looks good, works well, offers almost everything, and is low-priced. What more can we add?

Actually, we can add the warning which we always attach even when recommending a product as strongly as we do the 941B—Some people will be

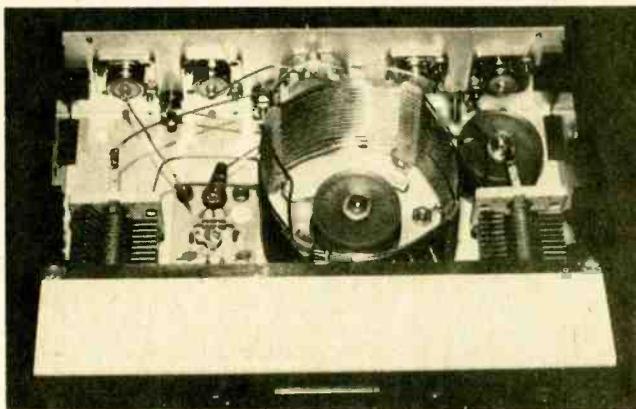
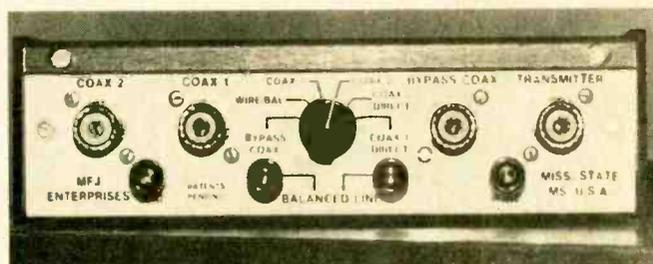


CIRCLE 78 ON READER SERVICE COUPON

MFJ 941B VERSA TUNER

A new transmatch with a host of features at a very low price

Rear panel of model 941B shows the full extent of the unit's versatility. Coax connectors for either of two antennas, bypass coax, balanced or unbalanced lines, and ground connection are easily visible.



Inside view exposes high quality construction employed in the 941B. Large airwound coil reduces losses due to heating. High capacity variable capacitors cut arcing, and good quality coax connectors are used throughout. Note solidly mounted toroid for 160-meters.

content to pass the entirety of their ham career working with just the power level supplied by the finals of whatever rig they happen to own. Usually, this is about 200 to 250-watts, which the MFJ can easily accommodate, as mentioned earlier. However, if you are contemplating moving up to linear amplifier operation now or in the future, spend the extra money required to pur-

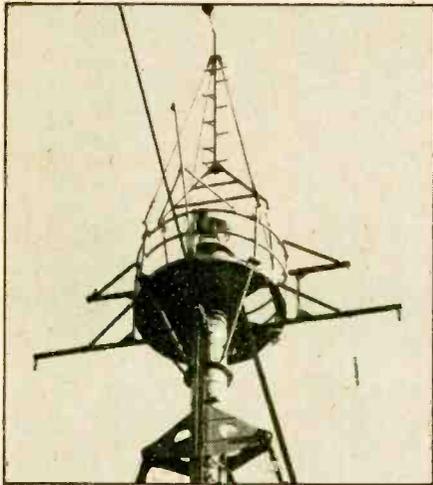
chase a transmatch which will handle the extra power, instead of kicking yourself later. The money you save now will probably double or even triple by the time you're ready to buy that high-powered station.

For more information, contact: MFJ Enterprises, Box 494 Mississippi State, MS 39762, or circle number 78 on the reader service coupon. ■

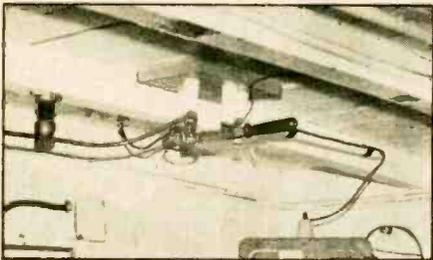
Wireless at Sea

A working exhibit of shipboard radiotelegraphy

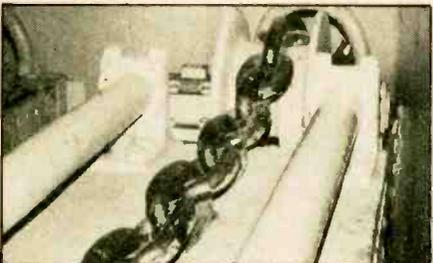
BY PAUL MARGOLIS



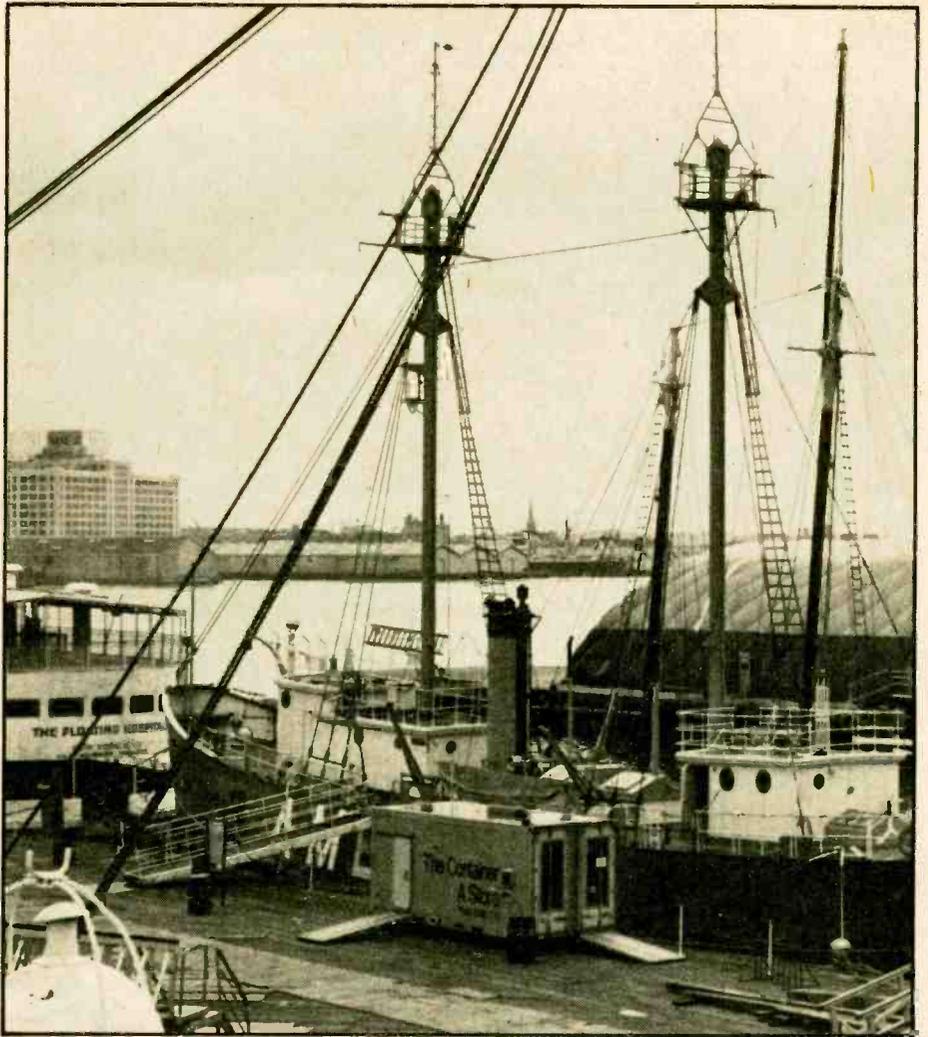
This shot of the forward masthead of the Ambrose shows the termination of the 80 meter long-wire antenna at the insulator.



Throwing the massive pivoting knife switch selects the 40 or 80 meter antenna, or the low-frequency receiving antenna coupling.



Heavy chains attached to a pair of 2½ ton anchors moored the lightship on station.



THERE'S A UNIQUE MUSEUM exhibit afloat in New York Harbor. Housed aboard the old Ambrose Lightship, this exhibit displays a working recreation of a ship's radio room.

The Ambrose project came about as the result of the combined efforts of the South Street Seaport Museum and the Veteran Wireless Operators' Association. The South Street Seaport Museum, located at the lower tip of Manhattan, was established to preserve the nautical crafts and memorabilia of New York Harbor and the vessels that frequented it over the years. A variety of ships, boats and nautical exhibits are displayed at the museum piers and complex. There are ship tours and demonstrations of nearly forgotten nautical arts such as rope splicing and sail hoisting on a square-rigger.

The VWOA. Some three years ago the Veteran Wireless Operators' Association (VWOA) proposed establishing a radiotelegraphy exhibit aboard one of the ships at the museum. This organization, made up of active and retired

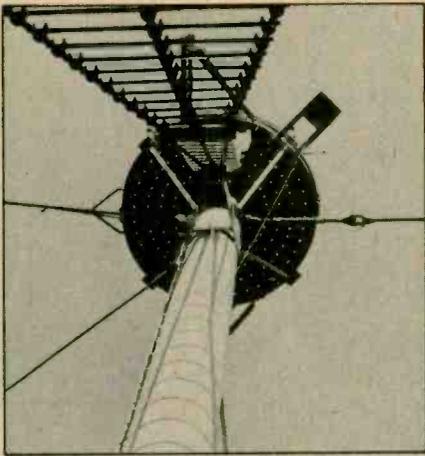
commercial radio operators, was interested in demonstrating their craft to the Seaport Museum visitors.

While theirs is not as ancient a maritime skill as rope handling or caulking wooden decks, ships' wireless operators have nevertheless made valuable contributions to safety at sea. Even today, with all the advances that have been made in communications, ships still carry at least one radio operator.

Wireless telegraphy at sea came into its own after the 1912 Titanic disaster, when that luxury liner struck an iceberg and sank with a large loss of life, even though it was within well traveled shipping lanes. Had newly developed wireless been mandatory on ships in those days, many who perished might have been saved.

Throughout two World Wars and the maritime disasters of peacetime, it became tradition that the radio operator and the captain were the last to abandon a sinking ship.

Thanks to generous donations of time and effort by VWOA members, and



The after masthead, with housing supporting the 40 meter long-wire antenna termination. Note the wire rope mast guys.



The original shipboard radio equipment shown here are tuned to work the 40 and 80 meter amateur communications bands.



This National Radio Corporation long wave receiver dates from the 1930s. Sets like this one were used aboard ships and at coast stations to monitor distress calls and ship-to-ship traffic on the low-frequency bands below 500 Kilohertz reserved for these purposes.

shipboard radio equipment by RCA and ITT, the VWOA was able to set up an accurate replica of a ship's radio room. The equipment includes a pair of RCA transmitters, one low frequency (500 kHz) and the other high frequency (2-22 MHz), a Hammarlund SP-600 general coverage receiver from ITT and a National low frequency receiver. To keep things as authentic as possible, they even included a 1930's vintage Underwood telegraph "mill" (all capitals typewriter).

The Ambrose Lightship is an especially fitting home for the wireless exhibit. For more than half a century following its commission in 1908, the lightship guarded heavily trafficked shipping lanes, guiding ships with its powerful light, foghorn and radio beacon.

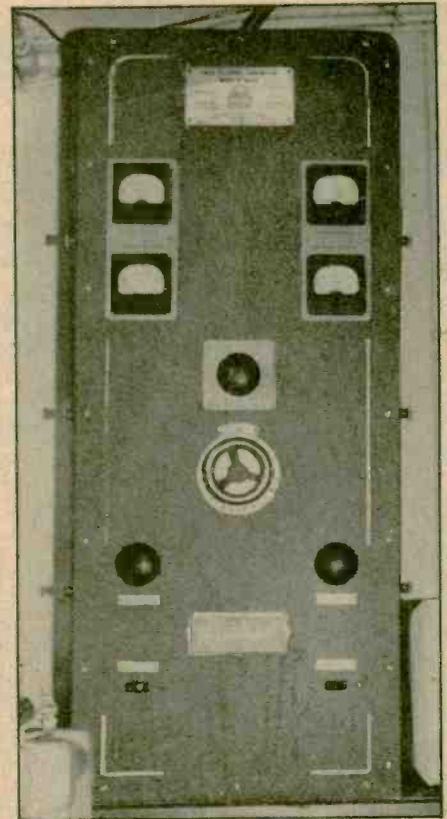
South Street Seaport arranged to have bulkheads built in the old radio beacon transmitter room at the stern of the 135-foot vessel, and the VWOA members saw to the installation and operation of the equipment.

Amateur radio is the natural hobby of the members of the VWOA, many of whose careers in radio span the en-

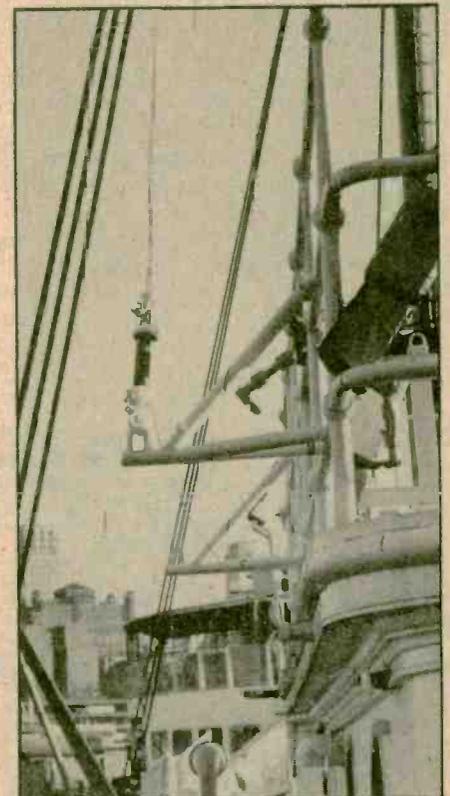
tire history of wireless communications. A variable frequency oscillator was hooked to the RCA 2-22 MHz high frequency transmitter, so that it could be used to work the 40 and 80-meter ham bands from the ship. The transmitter is coupled to the ship's original long-wire antennas.

Morse Code Still Used. During the warmer months VWOA members stand radio watches aboard the Ambrose on Sunday afternoons, showing museum-goers a shipboard radio station in operation. The most common question asked by visitors to the Ambrose—who often stand and marvel at the warm orange glow of the final tubes and the sparks that jump when the large antenna knife switch is thrown to put the transmitter on the air—is, "Do they really still use Morse Code?" Many are surprised to hear that code is very much alive, that under some circumstances it is more effective than voice.

The radio room aboard the Ambrose is a working exhibit of shipboard radiotelegraphy. It is also a tribute to the men and women who serve as the vital communications link for ships at sea. ■



While not licensable for amateur use, this RCA low-frequency transmitter lends an authentic touch to the Ambrose's radio room.

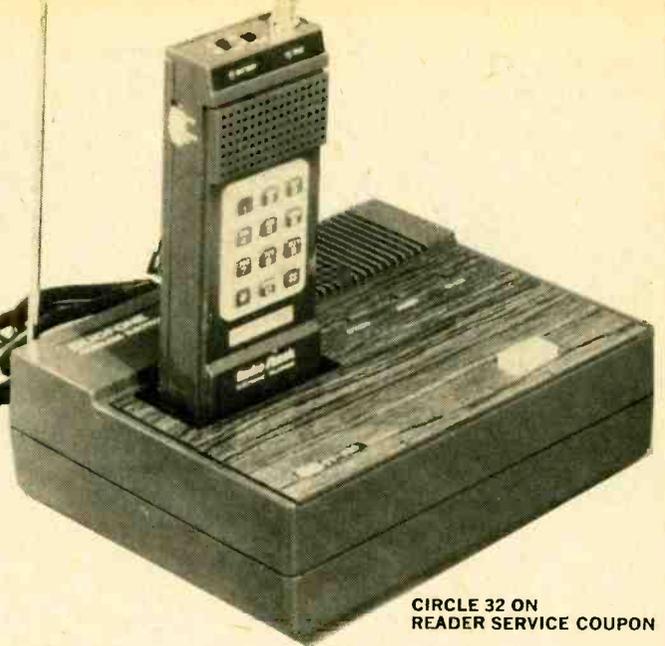


The 40 meter antenna line feeds from the transmitter, through the port bulkhead via an insulated fitting, and up the after mast. The Brooklyn skyline is in the distance.

E/E CHECKS OUT THE...

Radio Shack ET-300 Cordless Telephone

This lightweight transceiver allows new mobility at home or work



CIRCLE 32 ON
READER SERVICE COUPON

"THIS IS JAMES BOND," you may be tempted to tell the operator. In your hand is a compact, two-way telephone handset, no larger than a standard slimline walkie-talkie. Red LED status lights glow reassuringly, signaling that the small transceiver is working perfectly. A touch-tone pad sits ready for your dialing command. A chromed telescoping whip collapses into the case for additional compactness.

We are indeed in an age of electronic wizardry, where product descriptions seem to be limited only by imagination. Recently, a number of manufacturers have released cordless telephones, designed to cater to creature comfort. Now you may answer or dial your telephone from the garden, your bathroom, a factory work area, or anywhere within several hundred feet of your base unit. Formerly an expensive luxury, the price of cordless telephones is dropping dramatically. And best of all, the quality is not dropping with it!

Features. Among the recently-intro-

duced cordless telephones, Radio Shack's ET-300 is of particular interest. Not only is it small and packed with features, but it is inexpensive. Internally, the ET-300 is unusually compact. The PC board is densely populated with components comprising a full duplex transmitter-receiver. The remote telephone transmits on the 49 MHz band and receives in the 1.7 MHz band. Both of these frequency ranges are allocated by the FCC for low power communications use.

Frequency modulation techniques are used to help reduce electrical pulse noise which could be especially severe at the lower frequency range. Although it is theoretically possible for one of the new license-free 49 MHz walkie-talkies to interfere with the system, such problems will probably be very rare. Christmas, 1979 was the first opportunity for such a confrontation, and it will be interesting to note how much interference was experienced. If interference does occur between cordless telephones and walkie-talkies, several alternate channels are available for the telephones. Dealers or service centers should be able to effect the conversion.

Transmit power of the handheld remote is 250-milliwatts with narrowband modulation. Receiver selectivity is ± 8.5 kHz at -6 dB, ± 30 kHz at -60 dB. The tiny remote is powered by nickel-

cadmium batteries, and uses only 12-milliAmperes of current on standby, and 60 mils during transmit. The unit measures $2\frac{3}{8}$ -inches by $6\frac{3}{4}$ -inches by $1\frac{1}{4}$ -inches and weighs 20-ounces.

The base unit is also a full transmitter-receiver, as well as a combination telephone interface/battery charger. A cable with a modular connector is provided in order to mate the ET-300 with a conventional telephone outlet. In addition, a female modular plug is accessible on the rear apron of the base unit to receive the plug from the regular telephone so it may be used.

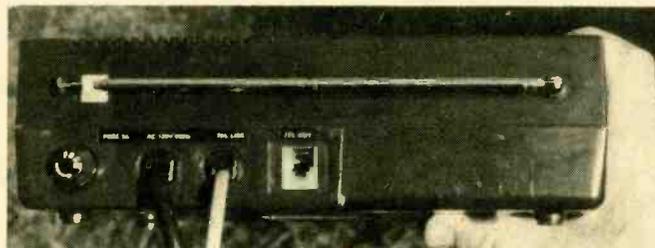
Operation. We found the performance of the Radio Shack cordless telephone very acceptable. True, at first we found the flat profile of the cordless remote to be somewhat awkward when held like a normal handset. Worse, our cheekbone kept depressing one of the buttons, disconnecting the telephone momentarily from the line! But continued use provided better familiarization, and operation of the unit soon became simple and dependable.

The remote is left cradled in the base unit/charger when not in use. NiCad battery replenishment is swift, and overnight charging will compensate for all-day normal use of the hand-held remote. Should the batteries start to show significant discharge, a red LED

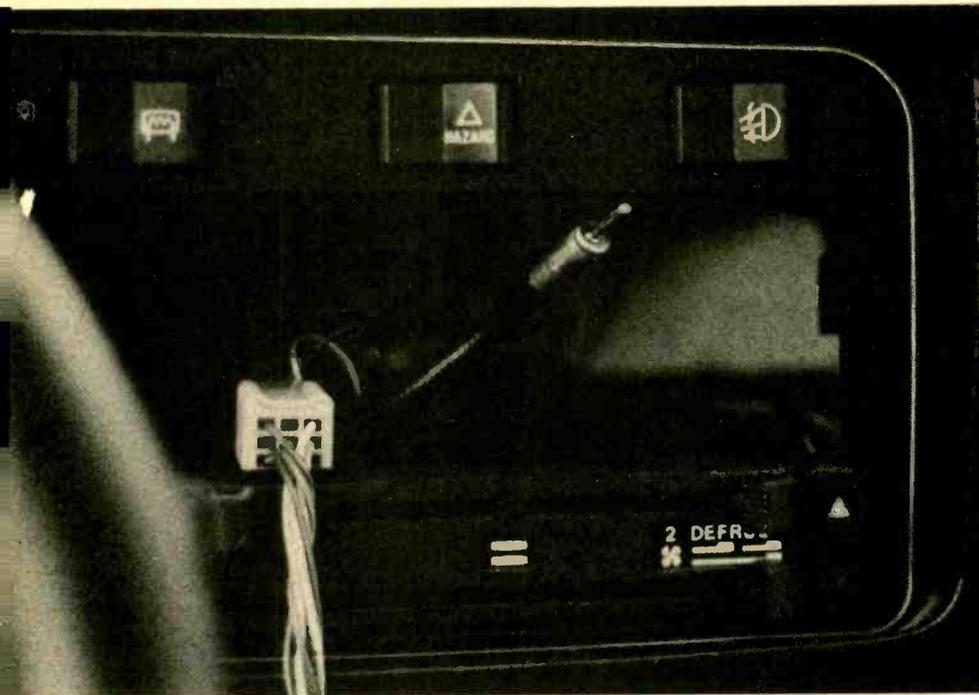
(Continued on page 83)



With switch in "standby," unit will respond to tone paging over long distances.



Low profile of base unit allows for convenient placement anywhere in the home. Whip antenna shown is for the 49 MHz link. The 1.7 MHz antenna is actually the AC line cord.



Electronic Equipment and your Auto Insurance—A Closer Look

Are you sure that your gear is really insured?
BY ROBERT E. MONTGOMERY

ARE YOU CERTAIN that the electronic equipment that you have in your automobile is insured? Have you called your insurance agent lately and asked? If you haven't, you could be in for a surprise! Far too many CB, ham, eight-track or cassette stereo users, and now owners of "on-board computers," have no idea if their units are insured or not.

Too many of us assume that the "comprehensive" coverage of our insurance policy will automatically cover these items. Chances are, that NONE of the equipment is covered!

Some "old timers" scoff at this statement, but things have changed, fellas, and CB radios might be the cause for these changes. Let's look at this new problem piece by piece.

The Special Policy. As the two meter and CB boom swept our country, so did thefts of this type of equipment. This high theft rate forced the insur-

ance companies to make a move on their own. So, along came the special radio policies. This "special" policy is really an extra policy that is attached to your present automobile comprehensive coverage. Therein lies the nub of a lot of misunderstandings. A point to remember is that if your automobile's comprehensive coverage calls for a fifty or one hundred dollar deductible, then the same deductible applies to the special radio attachment policy, too.

The cost of this "special" radio policy will vary from company to company and is based on the *retail* value of the insured equipment. This rate seems to vary from eight to eighteen dollars and up per year. Another factor that usually comes to the surface only after you have filed a claim, is the *depreciation factor*. Again, this will vary among different insurance companies, but a rule of thumb seems to have been standard-

ized: The figures the companies use for depreciation, usually run at one percent per month after the initial year. This means that if your CB or ham rig was stolen after two years of use, it would have depreciated twenty-four percent.

What's it Worth? With this material in mind, let's look at a couple of examples of just how this would work. John Doe purchased a new single side-band CB radio for \$250.00. A year and a half later, his unit is stolen. His comprehensive coverage on his automobile contains a \$100.00 deductible. He has also purchased the requisite "special" CB radio policy as an attachment (rider). This rider costs him \$10.00 per year. This is how his claim might possibly be computed:

Original purchase price	\$250.00
His deductible is	\$100.00
1½ years depreciation	\$ 45.00
Premiums paid	\$ 15.00
Total Reimbursed	\$ 90.00

Once again, this will vary with different companies. Also, in this example, we have deducted \$15 for premiums paid in. John D. would actually receive a check for \$105.00, but try replacing your rig for that! By the same token, how about the CB'er that owns a \$39.95 discount special? We're sure you've already seen the light. He gets zilch!

In interviewing insurance agents, we found that about fifty per cent of the insuring companies will replace your stolen unit rather than mailing you a check. This appears the better of the two deals. But it carries what may be an unfair advantage for the insurance companies that follow this practice.

In our previous example of the \$250.00 SSB unit, if the company replaces this unit with something comparable, you feel ahead of the game, right? Well, maybe! The insurance company often purchases the replacement from a distributor at, or somewhere near the distributor's cost. In our example, let's say the cost is \$150.00. The point here is, why should your "special" CB radio policy have a premium figured from the retail price of \$250.00? In reality, the premium should have been figured at the distributor's (or replacement) cost!

Now, with so many of us increasing our deductibles to keep our ever-increasing premiums down, these "special" policies are even more useless. In conversations with practicing insurance agents, it was found that they too feel that these special attachment policies are just not worth the money one must pay for them. The only exception

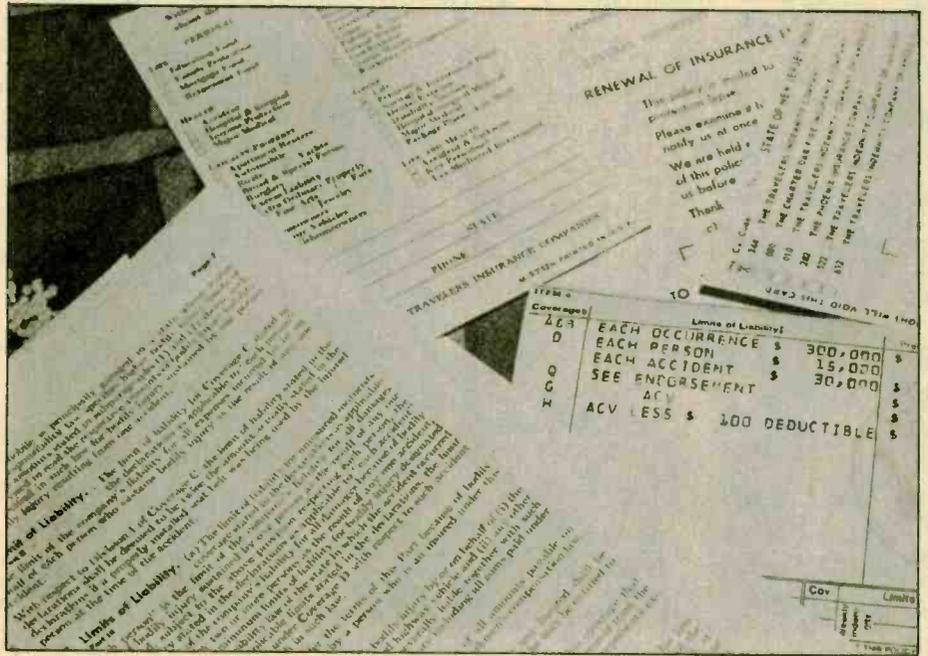
would be the radio enthusiast that has several hundred to thousands of dollars worth of equipment in his mobile.

In defense of the insurance agents, it should be pointed out that they, by selling you this "special attachment policy," do so only to protect themselves from you. If you were to have your radio stolen and called your agent for reimbursement, only to find that your rig isn't covered at all, you would certainly be upset and the agent could lose you as a valued customer. Also, the agent makes only one or two bucks by writing this "special" policy rider, but no more than that. It's easy to see that the agent isn't pushing the policy to make money, but rather to insure his or her integrity as a competent agent.

Cassette and Eight-Track Players.

These tape players are generally covered under much the same conditions as the aforementioned radios. We can add in vehicle telephone systems here, too. Of course, while the costs of stereo players and telephone systems are as far apart as one can get, they still provide us with the insight as to what is worth paying an extra premium for, and what is not.

A very elaborate stereo system could have cost you many hundreds of dollars and, of course, merit special insurance. However, what about the \$49.95 eight-track and two inexpensive speakers? Don't waste your time and money. Mobile telephones, on the other hand, are very expensive items and should be insured against theft. They can run into



Don't wait until after you've been ripped off to check your policy's coverage. The best source of information (unless you can decipher your policy's legalese) is your agent.

the thousands of dollars and most certainly will require your agent's advice on insuring them. A good rule to follow is that almost all sound reproducing equipment will require the special attachment policy or it is not insured!

The exceptions to this rule are the CBs, stereo players, etc. that are *factory-installed* in your car. Your comprehensive auto insurance will cover these units as they are "an integral part of the assembled vehicle."

This brings us to the "onboard computer." This calculator-styled unit is appearing in more and more cars as its use becomes known. The onboard computer can tell you everything from the time of day to how many miles you'll be able to travel on the gas remaining in your car's gas tank. Until recently, these units were found only in the luxury cars and were considered "an integral part of the automobile." But now, many companies offer them as "add-on" devices for almost any car. So, here we go again.

As of this writing, the majority of companies do not list these computers on their "extra insurance needed" lists. The agents interviewed warned that because they were slowly becoming a popular "add-on," the companies would surely soon insist on special insurance for them, too.

Conclusion. The only safe answer to this insurance dilemma is to contact your agent. Have him explain the deductibles and depreciation variables that are contained in your particular automobile insurance policy. With what is (and what isn't) covered changing almost daily, your agent is the only one that can give you the true figures. Don't wait until you have a claim to file, check it out and add it all up! You may be surprised at what you may learn. And what you learn may just save you some trouble and, more importantly, a lot of money.



Question: Which of the car-fi and communications gear seen here would normally be covered by a standard automobile insurance policy? See the text for what may be a surprise answer.

Antique Radio Corner

Troubleshooting Automatic Volume Control

BY JAMES R. FRED

□ Those of you who restore the early AC-operated radios know the aggravation of signal fade on your favorite stations. Imagine how it was when the set was new and there weren't many local stations and those that were on the air were usually running only 50-watts. Reliable daytime radio reception was limited to a 25-mile radius from the transmitter. At night, because radio waves travel much farther than they do during the day, there was considerable interference between stations, and fading became a real problem. After a few minutes of listening to a strong local station, it might fade out to be replaced by a weaker, more distant one.

It wasn't until the introduction of the multi-element tubes that reception could be counted upon on a reliable basis no matter what time of day the listener wanted to use his or her radio.

Grids and Tetrodes. When screen grid tubes were introduced, i.e. 24 and 35/51, they were referred to as tetrodes because there were four active elements. There were five base pins plus a top cap connector on AC-operated filament tubes and four base pins and a top cap on battery-operated filament tubes. The tetrode had an additional grid inserted between the control grid and the plate. A DC voltage, which was less than the plate voltage, accelerated the flow of electrons from the filament or cathode to the plate. The result was that the tetrode had a much higher amplification factor than the triode. This tube was used as an RF (radio frequency) amplifier and as an IF (intermediate frequency) amplifier. Another advantage was that a tetrode did not need to be neutralized when used as an RF or IF amplifier.

The next step was to insert another grid called a "suppressor grid" between the screen grid and the plate. This grid was usually grounded or connected to a highly negative voltage. In AC-operated tubes, the suppressor grid was brought out to a separate pin resulting in a six-pin base with a top cap connector. In battery-operated tubes, the grid was internally connected to the center of the filament. In tetrode tube operation, electrons were often dislodged from the plate as it was bombarded with electrons from the filament. These secondary electrons would collect on the positively-charged screen

grid and increase its current flow and reduce the amplification of the tube. Putting the negatively-charged suppressor grid next to the plate deflected the secondary electrons back to the plate and thus increased the plate current and reduced the screen grid current. This tube was called a pentode.

The development of the remote cut-off tube, usually called a variable-mu tube, allowed for the design of radio sets with automatic volume control. By merely varying the control grid bias, the amplification factor of the tube could be varied, and it could be used to prevent fading of signals.

Diode Rectifier. At the same time the variable-mu tube was developed, there arose a need for a diode rectifier that could be built into the same glass envelope with a triode or a tetrode. The diode (two elements) is essential because it is one of the few simple tube structures which produces a direct current proportional to the carrier wave of a signal. The diode plates, being very small, were usually built into the same envelope with a triode, becoming the 55, 75, or 85 types. There were some diode-only tubes such as the 6H6 and the 6AL5. The duo-diode-triode tube was usually used as a detector and source of AVC voltage with variable-mu tube types.

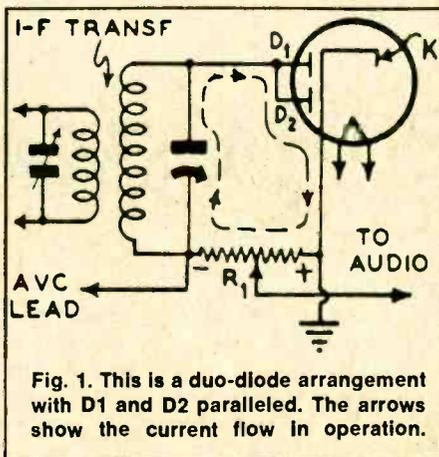


Fig. 1. This is a duo-diode arrangement with D1 and D2 paralleled. The arrows show the current flow in operation.

If you will refer to fig. 1, we will discuss the operation of the duo-diode-triode tube. The two diode plates, D1 and D2, are tied together and to one lead of the last IF transformer secondary. The signal voltage is rectified (because no current can flow when the

diode plates are negative) and flows through R1. This resistor will be positive (as far as the signal is concerned) at its grounded end. A wire from the negative end then connects to the control grid return leads of the AVC-controlled tubes. Since rectification takes place in this diode circuit, the audio portion of the signal also appears across the resistor. The arm of the potentiometer connects to the grid of the triode section of the same tube and controls the volume of the radio receiver.

Some engineers prefer to keep rectification separate from AVC action, as shown in fig 2. This may be done by connecting D1 and D2 together through

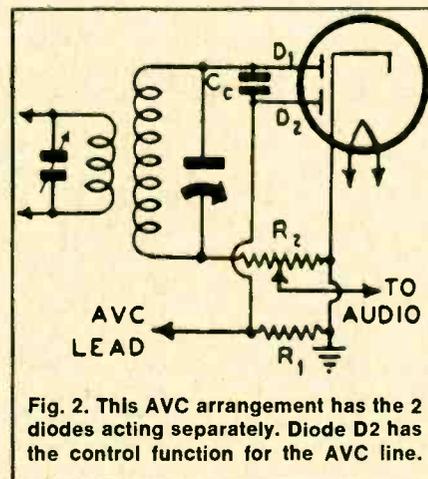


Fig. 2. This AVC arrangement has the 2 diodes acting separately. Diode D2 has the control function for the AVC line.

a small capacitor as shown. The rectified current due to D1 goes to the audio amplifier, and that due to D2 to the AVC lead. Each diode plate has its own load resistor across which the rectified voltage appears.

AVC System. Figure 3 shows a typical AVC system. Diode D2 rectifies the signal, a small portion of which is taken

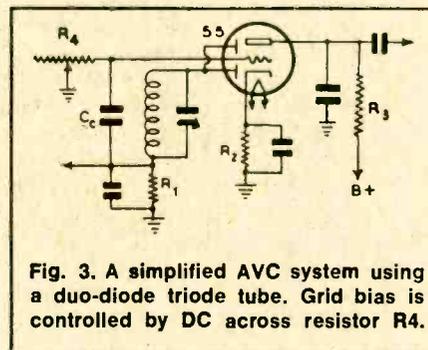


Fig. 3. A simplified AVC system using a duo-diode triode tube. Grid bias is controlled by DC across resistor R4.

Antique Radio Corner

from D1 through capacitor Cc. This rectified current produces a voltage across resistor R4. Now the voltage across R4 is of a pulsating type and therefore contains an average DC value and an alternating value; the alternating value is composed of the RF carrier and the audio signal. For the purposes of AVC, all the alternating components must be eliminated; only DC is wanted. It is the purpose of capacitors C1, C2, and C3 and resistors R1, R2, and R3 to filter out this alternating component and leave only pure DC.

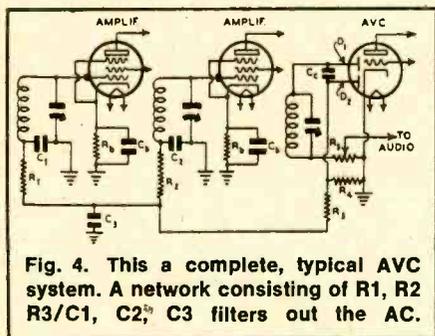


Fig. 4. This a complete, typical AVC system. A network consisting of R1, R2 R3/C1, C2, C3 filters out the AC.

In the simplified circuit of fig. 4, the action of the AVC voltage is easier to understand. The voltage across R4 is applied to C3 through R3. These resistors have high values, typically a half to one megohm, so that with a given strength carrier, the voltage across C3 is constant regardless of the audio variations. The grid bias of any tube is the bias voltage measured from grid to cathode. If a stronger signal is tuned in the DC voltage across R4 rises, increasing the total bias applied to the tubes which reduces the amplification of the tube. Conversely, if the signal drops in strength the total bias applied to the tube decreases which increases the amplification of the tube.

Troubleshooting Tips. In a well-designed radio receiver where the AVC voltage can be applied to several stages, the audio level will stay quite constant regardless of signal fading. When troubleshooting AVC circuits, the capacitors in the older sets will usually be found to be leaky or have high resistance readings. These capacitors should be replaced. It is also a good idea to measure the resistors and if their resistance varies more than 20% from the original value, replace them too. Leaky capacitors will cause low volume, poor sensitivity, and often will result in squeals and howls coming from the speaker. Learning to trouble-shoot AVC circuits isn't difficult. You must have

a VTVM or FET voltmeter, with 10-megohms or more input impedance, to measure AVC voltages. Apply your voltmeter to ground and to the junction of resistor R3 and R4 (see fig. 3 or 4). When you tune in a radio station, the voltage reading should rise and fall as you tune the station out. A local station should give a much higher reading than a faraway station. If this voltage reading doesn't increase and decrease as you tune the station in and out, you have a problem in the AVC circuit.

Setting Up Shop. In many cities of the United States, there were or are local companies founded by local inventors or handymen who had ideas for products they could manufacture. I am familiar with one such company, Kingston Products Corp. of Kokomo, Indiana, which got its start in the early 1900's when Ralph Kingston invented the Kingston Carburetor, an after market accessory for the model T Ford. Many other automotive products followed, such as spindle bolt assemblies, Fordson tractor manifolds, vacuum tanks etc. Additionally, the Kokomo Electric Co. was established, and late in the 1920's the Kingston Radio Corp. In 1945, several companies had been merged to form the Kingston Products Corp., which manufactured private brand radios for Western Auto Supply, Gamble-Skogomo, and Montgomery Ward, with the Kingston Radio Corp. acting as the sales company for radios. However, in this column we are now only going to mention products of the Kokomo Electric Co. One of the products they manufactured was the "Sea Pal" gasoline engine generator used to charge storage batteries.

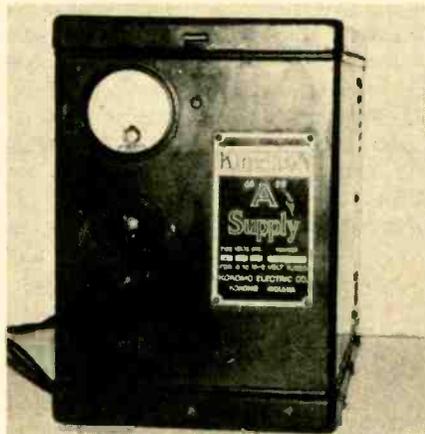
In the photographs you will see two devices I found this summer that were built by Kokomo Electric. One is a "B" battery eliminator and the other is an "A" battery eliminator. The "A" eliminator has the lid removed to show the components that are inside. At the rear is a copper-sulphide-magnesium rectifier, three large filter capacitors, and a transformer. Mounted on the front panel is a Weston voltmeter, an off/on switch and a variable voltage control. The name plate is nicely made and the case is painted with black enamel gloss.

The "B" eliminator used a cold cathode rectifier (mounted in the upper right corner). There were 4 binding posts and 3 voltage controls. This was quite unusual because a majority of "B" eliminators had 2 fixed output

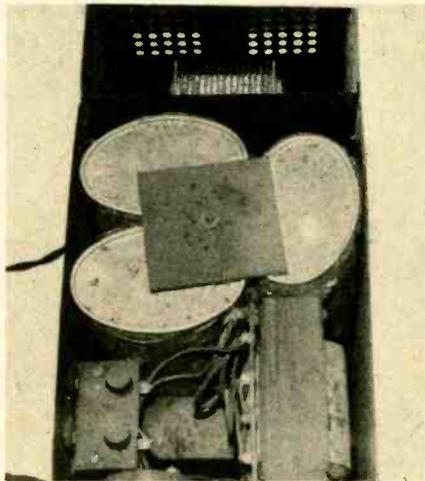
voltages and one variable voltage. In the old battery sets you could increase the sensitivity of the radio by selecting the optimum detector voltage.

One advantage Kokomo Electric had over other companies was its ability to manufacture many of its own components. I found that they fabricated their own sheet metal parts, and plated and painted their own steel parts. They also wound the power transformers, and wound, impregnated, and cased their own filter capacitors. Thus, they were able to easily control the quality of their products.

The Kingston Radio Corp. was formed in 1924. I will write more about this company in our next column. You can learn about radio factories in your communities. Just visit the local library and ask to see the old newspapers or microfilms of old newspapers between 1920 and 1930. ■



In this photo, the large size of the three ovoid filter capacitors is clearly shown.



An "A" supply pictured above, is just another name for an "A" battery eliminator.

E/E CHECKS OUT THE...

HEATH H89 DISK COMPUTER SYSTEM



CIRCLE 1 ON READER SERVICE COUPON

A built-in floppy drive, two Z80 CPUs and up to 48K of RAM give the H89 great potential

THE HEATH H89 DISK COMPUTER SYSTEM is a complete computer system designed for use by the entry-level hobbyist or business user, and as a replacement system for the hobbyist who started with a mickey mouse system that can't be expanded either for physical or economical reasons. The H89 includes two Z80 microprocessor chips, floppy disk drive, smart video terminal, heavy-duty keyboard with Selectric-type touchpad, calculator-type numeric keypad, and 16K of onboard RAM, for \$1695 in kit form, or \$2,895 fully assembled with 48K RAM and two serial I/O ports. Purchased assembled, the H89 is a good buy; at the kit price, it's an *inflation-fighter*. Moreover, the additional memory and I/O ports are available separately, and can be added to the kit at any time.

We took the kit approach in acquiring an H89 system because we believe that our readers will opt to utilize the

\$1,200 price differential between kit and assembled versions toward the purchase of a line printer.

Putting it Together. The H89 Assembly Manual takes the kit builder by the hand in typical Heath fashion, detailing each phase of the assembly procedure with reference to a pictorial diagram, and, when needed, with additional pictorialettes (what with every computer operator and manufacturer coining their own terms, why not computer editors as well!).

Errors will occur in assembly only when the builder becomes over-confident and fails to follow the instructions and diagrams faithfully. Our H89 was built with two assemblers sharing the work; one an old pro, and one with only one kit under his belt. Sure enough, the only two assembly flaws were traced to the fast soldering iron of the old pro who skipped a few "details" in one of the steps. By using the

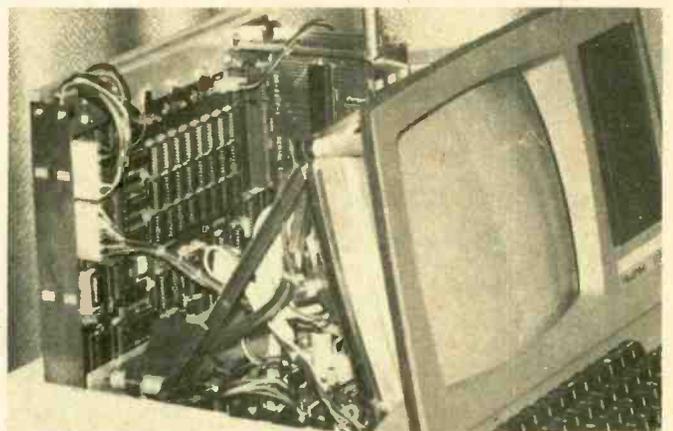
easy-to-follow troubleshooting section of the operational manual, we were quickly able to diagnose and correct our assembly errors.

Since we planned to use our H89 in as many ways as possible, we opted for the purchase of two 16K memory sets (H88-2 at \$150 each) to bring the kit's memory capability up to 48K. We also splurged on the preassembled multiport serial interface board (H88-5 at \$95). The disk drive, as mentioned earlier, comes as part of the basic H89 unit, and installing it in the terminal body consisted of a simple, step-by-step mechanical procedure somewhat akin to installing a cassette player in a car's dashboard. The serial I/O and cassette I/O boards posed no difficulty either in assembly or installation.

Obviously, we rate the Heath assembly manual very highly for its accuracy and thoroughness. The operational manual is every bit the equal of



The built-in mini-floppy drive is a great space saver as well as being the most efficient method for data storage available to the home computer hobbyist. Circle 1 on reader service coupon.



With the shroud removed, the motherboard, as well as the yoke and high voltage wiring for the CRT, is clearly visible. Note uncluttered layout making assembly easy, even for a novice.

the assembly manual in all areas.

Tech Specs. For those who have to "look under the hood," the following notes and technical details will no doubt be of interest. The Z80 clock operates at 2,048 MHz. The computer's memory map includes 8K of reserved system space in low memory, comprising 3K of ROM and 1K of RAM, with the remaining space not currently used. The top 8K of memory is also reserved, leaving the 48K of RAM from 2000 hex to E000 hex available to the user.

The CRT is a 12-in. (diagonal) tube with P4 phosphor coating, making it suitable for use in just about any room lighting conditions. The display matrix consists of 24, eighty-character lines (with access to a 25th line as well) with a display size of 6.5 by 8.5-inches. Character height is approximately 0.2-inch. Readability is enhanced through the use of the 5 by 7 dot matrix (upper case), 5 by 9 dot matrix (lower case with descenders) and 8 by 10 dot matrix (graphics). All of this adds up to a screen display capability of 2,000 characters (trust us).

The keyboard complement breaks down this way: 60 alphanumeric, 12 function/control, and 12 numeric/con-

trol. It allows for full cursor control plus the standard 8-column tabulator. Shifted functions give full cursor control for insertions and deletions.

The built-in disk drive is a Siemens Model 82 Microfloppy unit having 40 tracks with 10 sectors-per-track, and 256 bytes-per-sector. The data transfer rate is 128 kHz after a 1-second motor start-up time. The serial interface board provides two EIA RS232C channels (expandable to 3), with each being able to provide serial data and handshake at Baud rates of up to 19,200 continuously. The keyboard can set Baud rates of up to 9,600. The H88-5 cassette interface operates at 120 bytes-per-second, with mark and space frequencies of 2.4 kHz and 1.2 kHz respectively. The board can handle speed variations of up to 33% of normal (wow+flutter+speed difference) thereby eliminating faulty loading common to many other cassette interfaces.

Operation. The twin heart of the H89 (the two Z80 chips) allows the smart terminal and the computer to act independently of each other, allowing the H89 to process data faster. The programmed diskette available for the computer, the Distribution diskette

(H89-17), contains a sophisticated library of programs which control and facilitate operations. With this diskette, the computer is "booted up," and control of the system is turned over to the operator, with the following programs available: EDIT, ASM (assembly), DEBUG, BASIC (Extended Benton Harbor Basic), INT (initialization), ONE-COPY, SYSGEN (system generation), TEST, PATCH, BASCON (Basic from cassette to disk), and TXTCON (text file from cassette to disk). The other diskette (H8-21) contains Microsoft BASIC, a greatly expanded BASIC which the user will find invaluable when operating experience and proficiency call for greater programming versatility. Both the H89-17 and the H89-21 cost \$100 each. By the way, a BASIC diskette load in RAM is better than a built-in BASIC in ROM, because it is cheaper and easier to add new BASIC updates to the diskette.

Two thick looseleaf volumes describe the operation of the H89 using either of the two preprogrammed diskettes. However, these volumes assume that the user already has a working knowledge of the BASIC language, and provide nothing in the way of instruction to the novice. For the H89 user unfamiliar with BASIC, the Heathkit Continuing Education Course in "BASIC Programming," or a similar instructional tract, are *must* reading. One interesting section of the manuals is the "First Time Through" section which leads the user through the first-time "booting up" procedure of entry into one of the BASIC programs where the experienced BASIC programmer can begin to use the H89 without further system study.

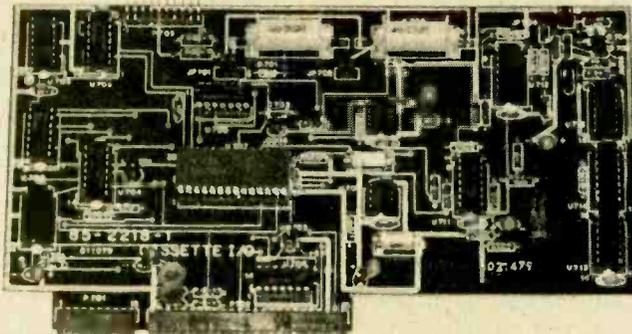
Our Opinion. The Editors have had about 4 weeks of operating time on the H89, and we are continuously finding new operational applications and nuances. Between the extended Benton Harbor BASIC and the optional Microsoft BASIC, no BASIC program has been found that the H89 cannot handle, even with light editing for syntactical differences.

The greatest limitation with our H89 setup is the lack of a line printer. In order to fully realize the magnitude of the H89's capabilities, a line printer is at the top of our shopping list for system additions. With inflation taking its toll on the electronics industry, as well as everything else, we probably won't wait too long before getting the line printer to make our H89 disk computer system complete. ■



As can be seen from the photo at left the documentation supplied with the H89 is rather thorough. The two manuals at left are supplied with the basic computer, and the two looseleaf binders accompany the optional software disc packages, as described within text.

This is the cassette serial I/O board, up to three of which can be simultaneously accommodated by the H89. The H88-5 interface allows cassette data transfer speeds of up to 120 bytes-per-second maximum.



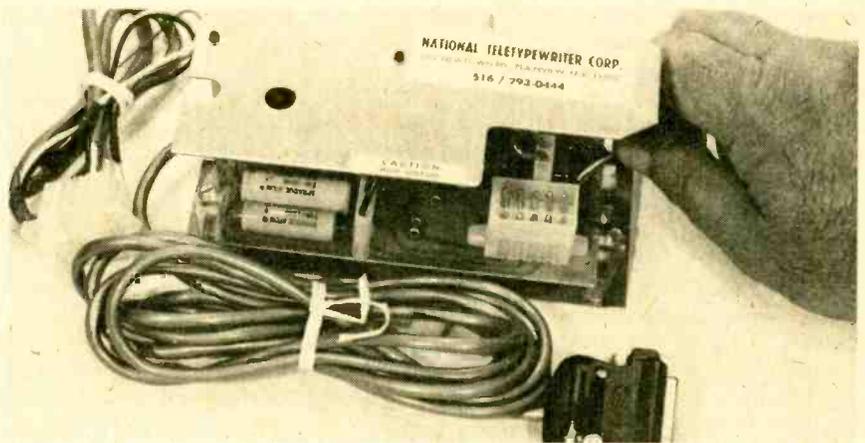
UNTIL VERY RECENTLY, the teletype writer—or TTY as it is more commonly known—was almost the universal computer terminal. Whether the operator was connected to a time-sharing computer via a modem and dial-up voice-grade telephone circuit, or directly connected to a school terminal, it was an odds-on bet that the terminal was a model 33 TTY (any version). One reason for the TTY's popularity was its ruggedness; it was, and remains, virtually student and slob-proof. Neither coffee, tea, milk nor soda spilled on the keyboard takes it down; it can run for years with absolutely no service; and it provides what is perhaps the most readable copy next to an impact printer such as a Selectric typewriter, or a Daisy-wheel printer.

Update for Home Use. But, as with all things, modern technology has moved beyond the TTY. It is simply too slow, among other things. The TTY operates at 110 baud, or 10 WPM (words per minute). The more modern terminals operate at 300 baud, or 30 WPM; a comfortable print speed to follow both on a video screen and *hard copy* (print-out). While the TTY requires a 20 mA current loop for operation, the 300 baud terminals send and receive voltage levels. The most popular voltage standard for hobby and personal computers is the EIA's RS232C, often called simply RS232, though there is an RS232B. The RS232C *rests (marks)* at a voltage more negative than -3 VDC. The bits which represent the ASCII encoded characters are voltage levels in excess of $+3$ VDC (equivalent to the TTY's *space*). The RS232B, which is generally seen only on surplus commercial printers, is simply reversed: the mark is positive voltage and the space is negative.

More and more, personal computers have utilized only the RS232C for I/O and printer. For example, the Radio Shack TRS-80 expansion interface accommodates an RS-232 I/O. Their small, less expensive printers are also RS232. The Heathkit printer is also RS232. Many of the new personal computers provide only for RS232.

To be honest, it's almost as easy to provide a 20 mA/RS232 I/O as it is a straight RS232, but that would cut down on the sales of rather expensive terminals and printers, for there are tens of thousands of perfectly good TTYs in school storerooms and on the surplus market. The personal computing hobbyist can often pick up an operating R033 TTY printer (no keyboard) for under \$250; a full terminal goes for anywhere from \$150 to about \$800 depending on condition.

Converting Model 33 TTY for RS232 Operation



Bargain converter lets you take advantage of surplus teletype printers

BY HERB FRIEDMAN

Conversion. Fortunately for the hobbyist and fortunate user of personal computers, virtually all RS232 I/Os can be hardware (switch) or software programmed for 110 baud. Now all we need is a device to convert the 20 mA TTY current loop to voltage levels and a TTY can be used in conjunction with an RS232 port.

While it's easy enough to build a converter, the device should have the long term reliability of the TTY itself. There's no sense in installing a device that will eventually require more service than the TTY. Also, it's not much more expensive to use a commercial device with special connectors that mate with the TTY's factory wiring than it is to *kluge* some homebrew on top of the TTY connections.

Though the information is not generally bandied about, there is a direct plug-in RS232C adapter for the model 33 TTY equipments: the R033 (printer only), KSR33 (printer-keyboard terminals), and ASR33 (terminal with tape punch and reader). The only problem is that the "official" teletype converter costs about \$300 and is one of the most difficult pieces of equipment to locate.

But as with all things, create sufficient demand and someone can make it for less than the "official" version. Presently, there is available to TTY rebuilders an industrial-grade RS232 converter that sells for about half what the "official" version goes for. Through special arrangement for our readers, the RS232 adapter is available direct from National Teletypewriter Corp., 207 Newtown Rd., Plainview, NY 11803.

Plug-in Simplicity. The National converter is a direct plug-in adapter, requiring nothing more for installation than a screwdriver and possibly a socket wrench. No technician should have any difficulty with the installation; the whole job shouldn't take more than 15 or 20 minutes, at most. Perhaps the only problem you'll have, if you have never worked on a model 33 TTY, is getting the cover off. So let's get the cover off first and then we'll get into the installation of the RS232 adapter.

Firstly, loosen the three thumbscrews on the back of the cover; there's no need to remove them. Next, pull off the paper feed knob, and the LINE/LOCAL knob on the right side of the front panel. They might be stuck, so

use a screwdriver to pry them off, or soft-face pliers. Pull both knobs straight out. Then, place your fingertips firmly against the metal front panel and slide your hands downward; the front panel trim strip will slide off, exposing four or five screws. Simply loosen these screws, or remove them. If you're working on a model ASR33—with tape punch and reader—there's a small screw on the left side directly below the tape reader that must also be removed. Gently, lift the cover up and off.

The RS232 adapter kit is shown in Fig. 1. It consists of an RS232 converter assembly with a prewired output cable terminating in a "standard" DB-25 plug that's wired according to the RS232 standard. It can be plugged directly into any "standard" computer or modem RS232 connector. In addition to RS232 input and output connections, the DB-25 provides a DTR signal (Data Terminal Ready) for I/Os that require the signal. If the computer or modem requires an RTS signal, (Request To Send) you simply move the wire connected to DB-25 pin 20 to pin 4. Most personal computer equipments don't require either the DTS or RTS signal.

The adapter's power supply is internal, and the 120-volt power line is provided by the TTY through the connecting cable that plugs directly into the adapter and the TTY. The connecting cable plugs into the large Molex connector on the PC board shown in Fig. 2. The opposite end plugs into the TTY. That's right, it plugs in. While most references to a TTY mention input/output from a terminal strip, there is a set of eight internal Molex connectors directly above the terminal strip used for direct accessory connections. The connector labeled #2 is the "professional" I/O. (More on this later.) In Fig. 2, the finger points to a small connector with a jumper. Pull this connector if you want full duplex operation (separate keyboard and printer functions). Leave the connector installed for half duplex operation (the printer prints whatever character is typed on the keyboard).

Remove the two screws at the top of the TTY pedestal's rear cover (panel) and lift the cover straight up and off. The adapter installs inside the pedestal on the top front lip, and has two clips for this purpose. As shown in Fig. 3, simply place the adapter against the bottom of the TTY near the pedestal lip and the push clips will lock onto the lip. The unit to the left of the

adapter in Fig. 3 is the ASR33's tape reader power supply which is similarly installed with built in clips. (If your TTY isn't an ASR33 you won't find any power supply inside the pedestal. Or it might be inside the TTY itself.) If the power supply is positioned in the center, blocking installation of the adapter, just slide it out of the way to the left. Don't try to improve things by using screws for the installation; the clips are the standard commercial mounting. Connect the end of the supplied connecting cable with all wires attached to the Molex to the adapter.

Fig. 4 shows the connector block panel in the TTY, which is located directly above the terminal strip usually used for I/O connections. The finger points to the #2 connector. Install the free end of the RS232 adapter cable into the #2 connector. Take note there are three free wires at this end: white; black, green. The white and black provide 120 VAC to the adapter and plug into terminals #1 and #2 on the TTY power transformer, which is directly behind the connector block. The green wire is the protective ground, and is secured under any screw on the metal supports behind the connector block.

If you have connections to the TTY's terminal strip, they can be left on but cannot be used because the converter will lock the printer to *mark* regardless of what comes in through the terminal connections. To have both the 20 mA and RS232 capability, install a small power switch in series with either the black or white lead to the power transformer. With the switch *off* you can use the 20 mA circuit through the terminal strip connections. **MAKE CERTAIN YOU DON'T HAVE BOTH SETS OF CONNECTIONS PLUGGED IN AT THE SAME TIME.**

When using the RS232 TTY with a Radio Shack TRS-80 computer, set the computer's RS-232 interface switch to COM. The TTY will not work if the interface switch is set to TERM.

Fig. 4. This is the connector block on the model 33. The finger is pointing to the jack into which the adapter plug from the converter will be installed. It's just a straight plug-in arrangement.

The RS232 adapter for TTYs is available for \$150 (includes postage, handling, and insurance) from National Teletypewriter Corp., 207 Newtown Rd., Plainview, NY 11803. ■

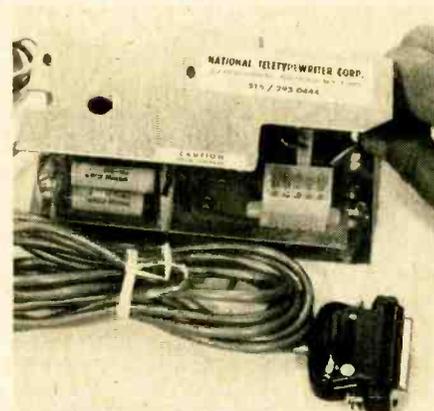


Fig. 1. The complete conversion kit, including both wiring harnesses and connectors.

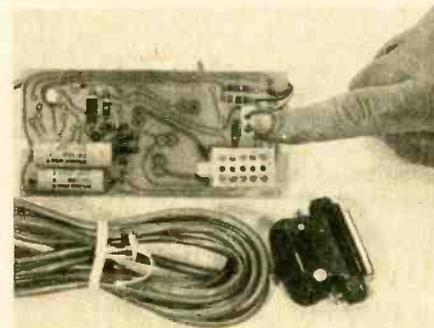


Fig. 2. Remove the jumper wire in order to achieve full duplex (separate) operation.

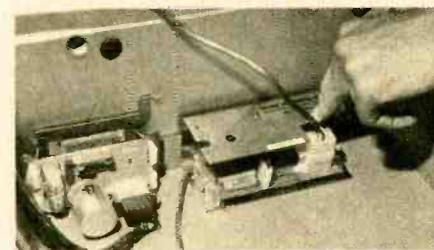
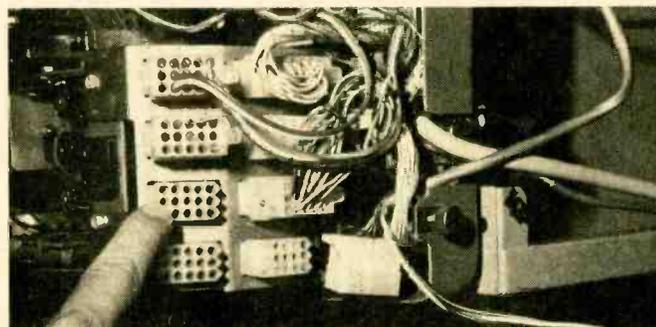


Fig. 3. Mount converter next to the power supply for the model 33's tape reader.



CB Spectrum

Bare bones CB is better than none at all

BY KATHI MARTIN KGK3916

ONE OF THE INSIDIOUS EFFECTS of the type of rampant inflation we've been suffering the past few years is that it forces people to postpone or eliminate the necessities of life—both big and small. The person having trouble stretching a dollar to put food on the table is likely to postpone preventive medical care, which can show up as a serious illness thirty years later.

In a similar vein, though certainly not of the same magnitude in importance, the same inflation might prevent a traveling salesman, or anyone else who spends much time on the highways, from purchasing a CB for the car, for the CB might represent a whole week's food bill for the family.

As with the medical expenses, the dollars saved on a CB might be more than offset by what it might cost to handle road service or a tow at a later date; a service or inconvenience that might have been avoided through CB.

No Frills CB. For those who need CB now, there's still a way to go without shooting a week's family expenses. Simply cut out all unnecessary frills and features, buying only basic CB performance and convenience. In this way you can bring down the cost of a complete mobile installation, including antenna, to well under \$100.

Let me explain how this works. Every feature on a CB rig, no matter how small it might appear, costs big bucks at the time you pay for the rig. An example of this is the P.A. speaker output jack that allows the transceiver to function as a public address amplifier when an optional speaker is plugged into the jack. Firstly, very few of you will ever have need for this function. Secondly, the jack and its associated wiring and switching can represent as much as \$5 of the selling price.

Let's look at *automatic noise blankers*. Few modern vehicles require a blanker; an ordinary automatic noise limiter will work just fine because a received CB signal with a level so low it requires a blanker, will probably be buried under interference anyway.

If your vehicle's self-generated noise is so high it affects reception of moderate to strong signals, you need new plugs and points, or an alternator noise suppressor, rather than a blanker. De-

pending on the transceiver design, a blanker can represent up to \$20 of the selling price.

By now you should have the picture; every convenience feature costs money; from a P.A. speaker jack to channel selectors mounted in the microphone. What do you get if you go bare bones? The Realistic TRC-420A from Radio Shack, catalog priced at \$79.95, is an example of what you can expect.

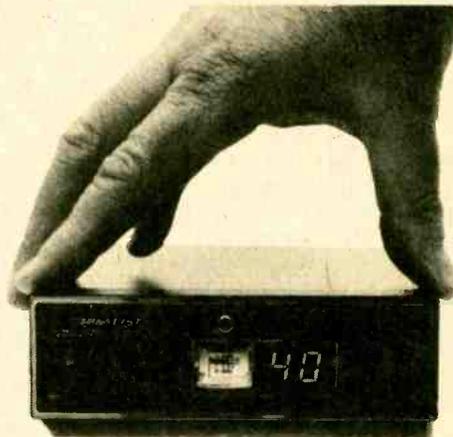
A "Realistic" Answer. The TRC-420A is a 40-channel AM transceiver for 12-VDC power sources with positive or negative ground. The first thing that strikes the eye is that it's unusually small, actually measuring only 1 $\frac{5}{8}$ -inches high by 5 $\frac{1}{2}$ -inches wide by 7 $\frac{1}{2}$ -inches deep. Even with the diminutive mobile bracket installed, the rig can be tucked under the dash of one of those new mini-bitty compact cars without taking up excess legroom.

Operation. A glance at the front panel tells you all there is to know. The most obvious feature is the relatively large, easy-to-see LED channel indicator. To the right of the channel

indicator is the channel selector. Over on the other end of the front panel are the volume and squelch controls. Just about dead center is a small S/RF output meter. Though the meter is calibrated in S-units (received signal strength), it really indicates relative received signal strength. Basically, the meter serves primarily to put your mind at ease by telling you there really is a signal on the channel, and the transmitter is really working.

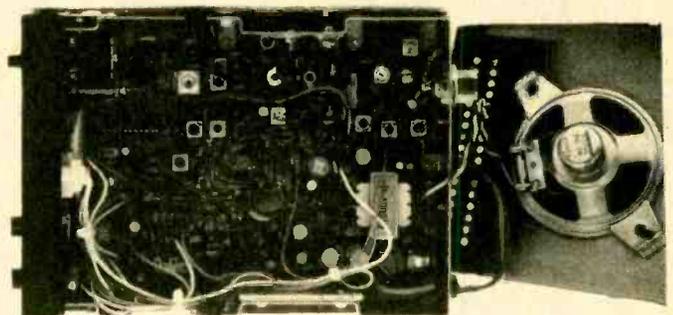
Above the meter is a noise limiter on-off switch. I have never understood the need for an ANL switch because the ANL must always be used in mobile operations. To the right of the switch, directly above the channel indicator, is a small modulation lamp that flickers as you talk into the mike. Again, it serves only to give you peace of mind—that the modulator is working and your voice is really going out.

Other than the ANL switch, about the only frill you pay for is an external speaker jack on the rear (another common feature I have found little use for, *(Continued on page 79)*)



The largest feature of this pint-sized performer is the LED channel readout—just as it should be. The only items on the rear apron are the antenna and external speaker jacks. But really, just how much more do you actually need to do the job?

The interior is very dense, in order to squeeze 40-channel capability into such a tiny package. One LSI chip (right) handles the digital circuitry portion. Circle number 32 on the reader service coupon for more information.



BACKPACK AMP

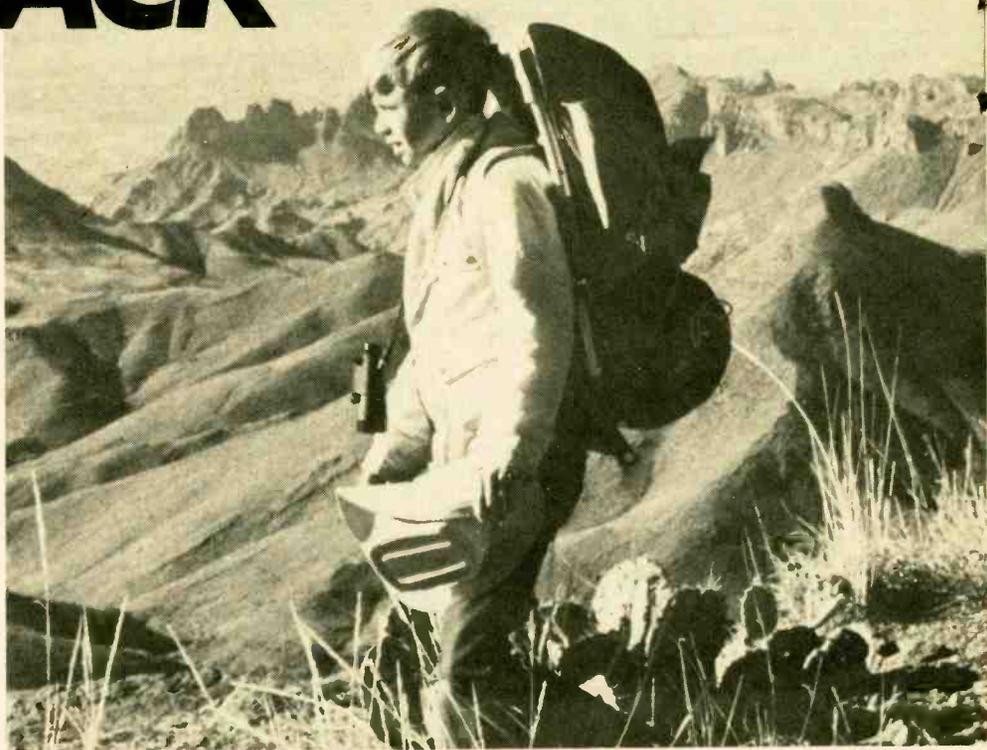
Make your own music anytime anywhere with this compact portable amplifier

BY HERB FRIEDMAN

MUSICIANS WHO PLAY acoustic instruments, such as trumpet, saxophone, or violin, for that matter, have never experienced the problem of the electronic musician on an outing where he or she is separated from an electrical source for an amplifier (assuming that one had even managed the task of bringing one along). It's admittedly pretty hard to entertain your friends with an electric piano which lacks electricity. What then, is the answer to this dilemma?

It's quite simple, actually—build a Backpack Amp. Designed to operate from "C" or "D" cells, or two or three small lantern batteries, the all-in-one-IC Backpack Amp will directly drive a speaker from the output of virtually any electronic instrument without need for additional amplification. Install the Backpack Amp in a small cabinet along with a 6 or 8-inch speaker and you can take your electric guitar, or whatever, with you on holidays.

The Circuit. The Backpack Amp is assembled on a printed circuit board measuring 2¾ by 3⅝-inches. All active components which make up the preamplifier and power amplifier are contained in a single LM383T inte-



grated circuit, which is available from Radio Shack. The resistor and capacitor values are considerably different than those given in the IC's data sheet (which is usually supplied with the IC). If you want the lowest distortion level from your electronic instruments use our values.

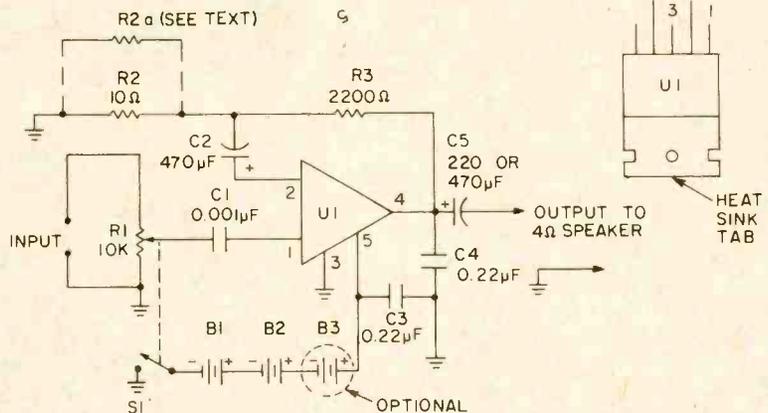
With a 12 to 18-volt power supply, the Backpack Amp will deliver from 1 to 3-watts into a 4-ohm load. Most replacement-type speakers are 4-ohms, and a 6 or 8-inch speaker is suggested. If all you have around, or can get, are 8-ohm speakers, we suggest you use two, parallel-wired 6-inch, 8-ohm speakers.

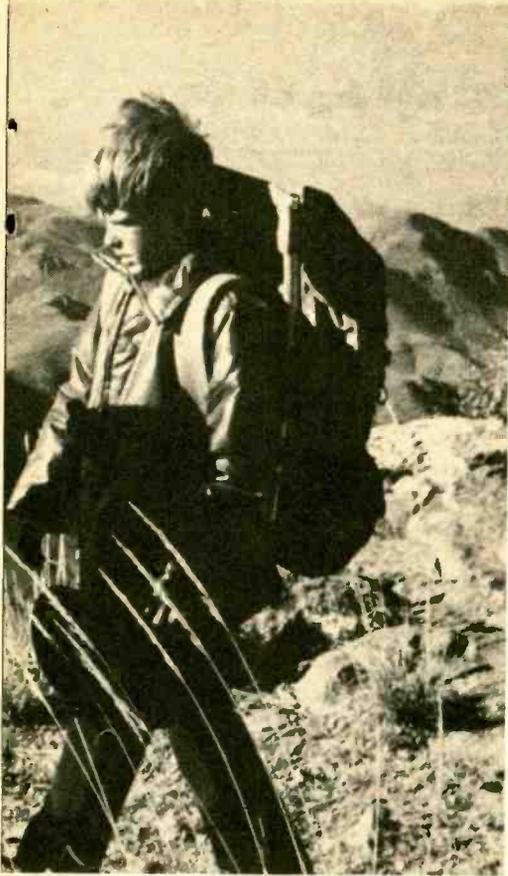
(The amp will work with one 8-ohm speaker, but 1-watt is about the maximum low-distortion output even with an 18-volt power supply.)

The value used for capacitor C1 is 0.001- μ F only if the amp will be used with an electric guitar. It compensates for the relatively higher low frequency output of an electric guitar pickup and prevents low frequency overload of the loudspeaker. If the Backpack Amp will be used with a synthesizer, you will probably be happier with the sound quality if C1 is 0.01- μ F. If you use a 0.01- μ F unit and find the low frequencies are overloading the speaker, sim-

PARTS LIST FOR BACKPACK AMP

- B1, B2, (optional B3)**—6-volt lantern battery (see text)
- Note: Capacitor voltage rating must be equal to power supply voltage rating.
- C1**—0.001- μ F mylar capacitor (see text)
- C2**—470- μ F electrolytic capacitor
- C3, C4**—0.22- μ F mylar capacitor
- C5**—220- μ F or 470- μ F electrolytic capacitor
- R1**—100,000-ohm audio taper potentiometer with SPST switch attached (S1)
- R2**—10-ohm, ½-watt 5% resistor
- R3**—2200-ohm, ½-watt 5% resistor
- S1**—SPST switch (part of R1)
- SPKR**—see text
- U1**—LM383T audio amplifier integrated circuit
- Misc.—Cabinet, screws, grille cloth, wire, solder, printed circuit etching materials, suitable input jack and matching plug, etc.





ply replace C1 with a 0.001- μ F unit.

The correct value for R2 is usually 10-ohms. If you find your instrument's output is on the low side, and you have all gain controls wide open and still can't overdrive the amp, then tack-solder another 10-ohm resistor (shown as R2a in the schematic) across R2. If you need even more gain, R2 can be lowered to 2.2-ohms, but keep in mind

that a 2.2-ohm resistor isn't the easiest of things to locate in this day and age.

Construction. Using any method you prefer, make the PC board using the supplied template. Note carefully the large copper foil area; it is part of U1's heat-sink and must not be eliminated. Don't substitute a thin foil strip as a ground connection. The foil rectangle in the middle of the PC board provides the anti-hum grounding for potentiometer (volume control) R1's shaft and frame. Again, don't substitute a thin foil strip because it might not contact R1's case when the potentiometer is installed. Depending on the particular style of potentiometer used, drill the proper size mounting hole where indicated by the dot in the foil rectangle.

Double-check the polarity of C2 and C5 before soldering. In particular, make certain C2's positive terminal goes to IC pin # 2. (It might not look correct but it really is.)

The IC must be mounted with a heat sink. From scrap aluminum, cut a section about $\frac{7}{8}$ by $1\frac{1}{4}$ -inch. Using the long dimension, bend a $\frac{5}{8}$ -inch tab. Drill a hole in the tab for a #4 bolt as close as possible to the "L" section (so as much metal as possible will be under the IC when the IC is positioned over the hole; but double-check that the tab does not touch any of the IC leads.)

Using long-nose pliers, bend U1's leads to correspond with the holes in the PC board. To avoid shorts, the leads are offset: Nos. 1, 3 and 5 are close to the IC body; Nos. 2 and 4 are bent about $\frac{1}{2}$ -inch away from the body.

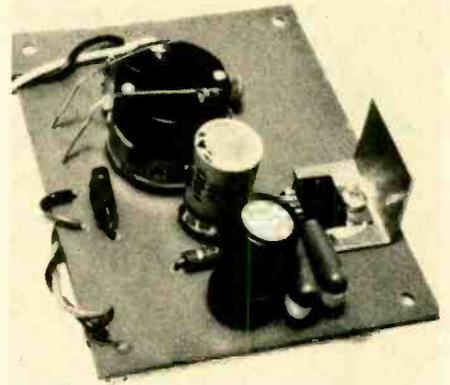
Place a drop of silicon heat sink grease on the underside of IC's mount-

ing tab, position the IC on the sink, and then secure the IC and sink to the PC board with a #4 bolt, lockwasher, and nut. Place the lockwasher between the nut and the heat-sink foil on the PC board, and tighten securely.

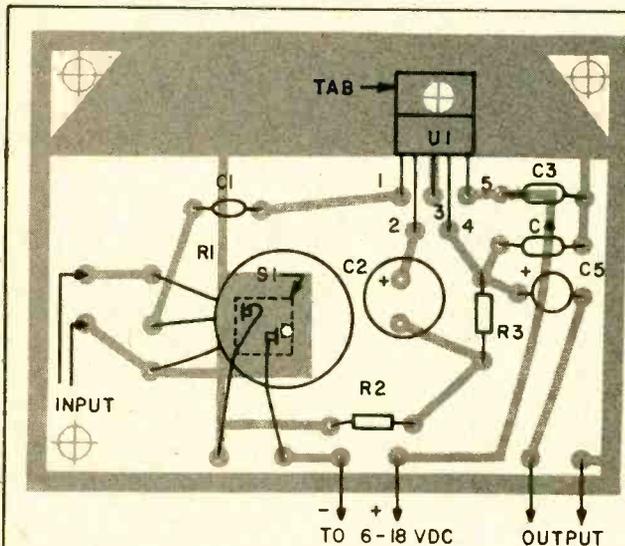
Installation. The Backpack Amp can be installed in any cabinet you prefer. (Note that it has a three-hole mounting.) If you can possibly locate a potentiometer bushing extender, which appears and then disappears in the marketplace from time to time, you can mount the amp with a single nut around the volume control's shaft.

While the power supply can be made up out of flashlight batteries, two or three series-connected small 6-volt lantern batteries make the most convenient and reliable portable power source.

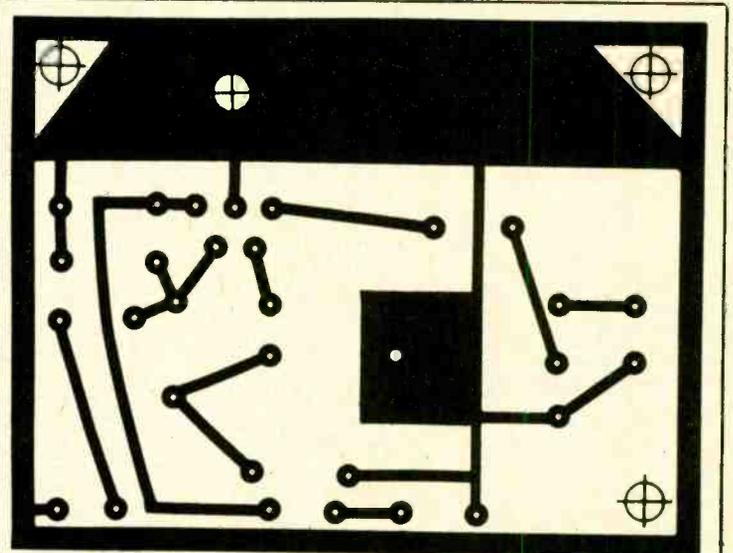
When it's all done, you and your ARP can head for the hills and commune with Mother Nature to your heart's content. ■



The completed PC board, showing U1 mounted with its homebrew heatsinks.



The component placement guide above shows the SPST switch mounted on the back of volume control R1 (dotted line box). External switch can be substituted for R1/S1.



The full-scale printed circuit template has two areas of solid foil which must be duplicated on your board. The large area at top helps heatsink U1, the other grounds R1 to minimize humming.

IT'S SIMPLY BASIC

Computerized Banking at Home

BY LARRY FRIEDMAN WB2AHN

CHECKFILE is a program that will keep track of your checks so you can instantly retrieve information; for example, if the IRS asks you to substantiate your charity deductions, you can quickly get a list of all checks issued to charities without the time-consuming bother of inspecting each and every check you wrote during the tax year. Another example? The tax man says you didn't pay the real estate tax on your home. Simply enter TAX and the computer will give the check numbers for each tax payment.

Checkfile will search the data file by CATEGORY (examples shown above), MONTH, or LISTALL (this command prints a list of all checks entered into the file). To use the CATEGORY or MONTH command, type in the com-

mand and, after hitting C/R (carriage return), enter the name of the category or month for which you want a listing of the checks.

The program can store up to 100 checks; however, if your computer has the capacity for more than 100, you can modify line 120 to accommodate as many checks as desired. It is also limited to 25 categories (that is, not more than 25 categories, such as the ones shown in the first paragraph, can be displayed by the computer). However, the limit of 25 was set only for convenience, and you can set any limit for the number of categories by modifying line 115. Lines 650-690 provide a list of all categories, by printing the first check from each category. Without this feature, each category might be printed

many times.

To start a file for entering checks, type NEW FILE when you're in the COMMAND mode. You may exit the NEW FILE mode by entering C/R when you are asked to enter the PAYEE's name. The OLD FILE command is used to add new checks to an old file. NEW FILE is located at lines 800-850, while OLD FILE uses the same lines, prefaced by lines 1000-1010.

To save this program on a Heathkit H-8 computer system with a tape recorder, type DUMP "CHECK." If you wish to save the variables along with the program, type FDUMP "CHECK." If you are using another computer system, or a different storage device, you may have to write a subroutine into the program to save the variables. ■

```

100 REM *
101 REM *           "CHECKFILE"
102 REM *
103 REM *           BY LARRY FRIEDMAN
104 REM *           WRITTEN FOR HEATH H-8
105 REM *           EX. BASIC VERSION 10.02.01.1
106 REM *           FOR ELEMENTARY ELECTRONICS
107 REM *
115 DIM JS(25)
120 DIM PS(100),C2(100),D2(100),MS(100),TS(100)
130 LINE INPUT "ENTER COMMAND ?"JC$
140 IF C$="LISTALL" THEN 200
150 IF C$="MONTH" THEN 400
160 IF C$="CATEGORY" THEN 600
170 IF C$="NEW FILE" THEN 800
180 IF C$="OLD FILE" THEN 1000
185 IF C$="STOP" THEN END
190 PRINT "SORRY, THAT COMMAND DOES NOT EXIST. PLEASE RE-ENTER"
195 GOTO 130
200 FOR R=1 TO 5:PRINT :NEXT R
210 PRINT TAB(15);"LISTING OF ALL CHECKES"
215 PRINT
220 PRINT "PAYEE","CHECK #","AMOUNT ($$)","CATEGORY"
225 FOR R=1 TO 100
230 IF PS(R)="" THEN 370
235 PRINT PS(R),C2(R),D2(R),TS(R)
240 NEXT R
370 FOR R=1 TO 5:PRINT :NEXT R
375 GOTO 130
400 LINE INPUT "ENTER MONTH FOR FILE SEARCH ?"JMS
405 FOR R=1 TO 5:PRINT :NEXT R
410 PRINT "PAYEE","CHECK #","AMOUNT ($$)","CATEGORY"
415 FOR R=1 TO 100
420 IF MS<>MS(R) THEN 430
425 PRINT PS(R),C2(R),D2(R),TS(R)
430 IF PS(R)="" THEN 440
435 NEXT R
440 FOR R=1 TO 5:PRINT :NEXT R
445 GOTO 130
600 GOSUB 650
604 LINE INPUT "ENTER CATEGORY FOR FILE SEARCH ?"JCS
605 FOR R=1 TO 5:PRINT :NEXT R
610 PRINT "PAYEE","CHECK #","AMOUNT ($$)"
615 FOR R=1 TO 100
620 IF TS<>TS(R) THEN 635
625 PRINT PS(R),C2(R),D2(R)
630 IF PS(R)="" THEN 640
635 NEXT R
640 FOR R=1 TO 5:PRINT :NEXT R
645 GOTO 130
650 D=1
655 FOR R=1 TO 100
660 FOR X=1 TO E
665 IF JS(X)=TS(R) THEN 685
670 NEXT X
675 PRINT TS(R)
678 JS(E)=TS(R)
680 D=D+1
685 NEXT R
690 PRINT :RETURN
800 I=1
801 PRINT "ENTER PAYEE, CHECK #, AMOUNT, MONTH, AND CATEGORY"
802 PRINT "ENTER ON SEPERATE LINES, USING C/R BETWEEN ENTRIES"
805 PRINT "(HIT C/R FOR PAYEE TO RETURN TO COMMAND MODE)"
810 FOR R=1 TO 100
812 REM INPUTS MUST BE ON SEPERATE LINES BECAUSE OF LINE INPUT.
813 LINE INPUT "PAYEE"
814 IF PS(R)="" THEN 835
815 INPUT "CHECK #"
816 INPUT "AMOUNT (IN $$)"
817 LINE INPUT "MONTH"
818 LINE INPUT "CATEGORY"
822 PRINT
830 NEXT R
835 PRINT
850 GOTO 130
1000 FOR I=1 TO 100
1005 IF PS(I)="" THEN 1010
1010 NEXT I
9999 END

```

SAMPLE RUN OF "CHECKFILE" BY LARRY FRIEDMAN

```

*RUN
ENTER COMMAND ?NEW FILE
ENTER PAYEE, CHECK #, AMOUNT, MONTH, AND CATEGORY
ENTER ON SEPERATE LINES, USING C/R BETWEEN ENTRIES
(HIT C/R FOR PAYEE TO RETURN TO COMMAND MODE)
PAYEE      *I.R.S.
CHECK #    *25
AMOUNT (IN $$) *435.85
MONTH      *APRIL
CATEGORY   *INCOME TAX

```

```

PAYEE      *
ENTER COMMAND ?LISTALL
PAYEE      *NAACP
CHECK #    *26
AMOUNT (IN $$) *188
MONTH      *MAY
CATEGORY   *CHARITY
PAYEE      *RED CROSS
CHECK #    *27

```

```

AMOUNT (IN $$) *188
MONTH
CATEGORY
*JUNE
*CHARITY

```

LISTING OF ALL CHECKES

PAYEE	CHECK #	AMOUNT (\$\$)	CATEGORY
I.R.S.	25	435.85	INCOME TAX
NAACP	26	188	CHARITY
RED CROSS	27	188	CHARITY

(Continued on page 83)

E/E CHECKS OUT THE...

PANASONIC RF-4900 RECEIVER



CIRCLE 72 ON
READER SERVICE COUPON

Three receivers on one chassis means high performance for the SWL

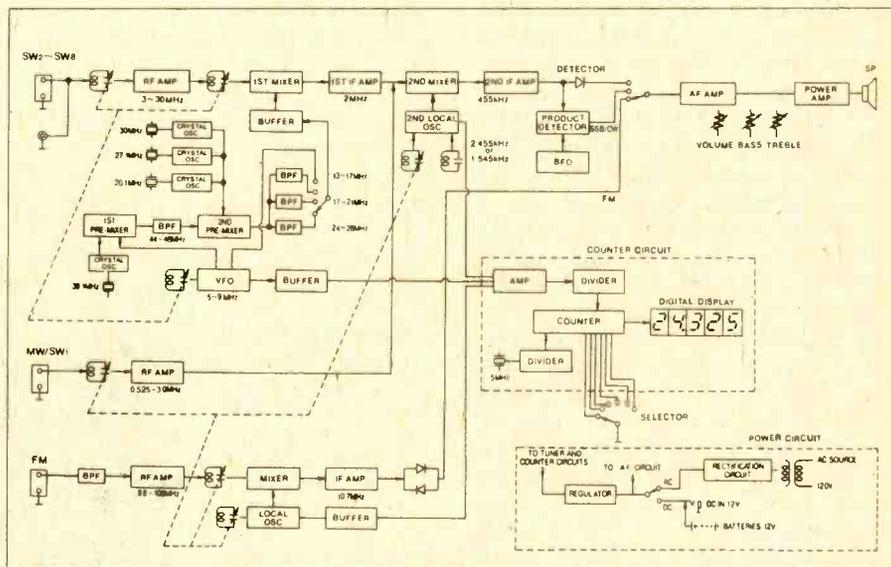
SOME CALL IT THE "Go Anywhere, Hear Everything Receiver." Others are simply too overwhelmed by its features and frequency coverage to think of what to call it. Whatever, the Panasonic RF-4900 Communications Receiver is a *tour de force*, providing just about every possible convenience for the short-wave/entertainment listener.

Housed in a cabinet measuring 18.9-inches wide by 7.8-inches high by 13.9-inches wide, and weighing approximately 17-pounds, the receiver provides reception from 525 kHz through 30 MHz, and 88 to 108 MHz (FM). Power sources can be either 120-VAC, eight "D" cells installed in the bottom of the cabinet, or a 12/13.8 VDC external power source (such as that of an RV or car).

Heading the list of operating features are both conventional and digital frequency indication on all bands, and this takes some explaining. The RF-4900 is effectively three separate receivers sharing a common power supply and audio amplifier. Three separate tuning indicators are provided. In the approximate center of the control section of the front panel is a five-place fluorescent digital display that's active on all bands. For example, an FM station might indicate 101.7, an SW sta-



This closeup shows the two log scales and digital display in the center. Circle 72 on the reader service card for information.



Following the block diagram, it can be seen how all tuning functions are tied in to the digital tuning display unit. You might try to isolate all three separate receivers.

tion might be 14.291 (MHz), and a broadcast station could be indicated as 1010 (kHz).

To the left of the digital display is a tuning dial calibrated from 530 kHz to 3 MHz, with a separate band for 88 to 108 MHz.

To the right of the digital display is a seven-band dial for the frequencies of 3 to 30 MHz. Two band selectors determine what frequencies will be tuned, and two tuning knobs provide the tuning. One knob is for the frequencies on the left dial, while the other knob, a dual speed (fast/slow depending on whether the knob is pulled out), tunes all frequencies on the right dial, and also serves as the vernier tuning.

Three-in-One. Now getting back to our three receivers, here's how it's done. Firstly, each has its own separate antenna input(s). The broadcast band range has a rod antenna mounted on the back of the cabinet. A set of spring-

loaded binding posts for the 1.6 to 3-MHz coverage also serves as the external antenna connection for the broadcast band. A set of spring-loaded terminals and a parallel coaxial jack are the antenna terminals for 3 to 30 MHz. Spring-loaded terminals are also provided for 88 to 108 MHz coverage.

The basic receiver section covers 3 to 30 MHz with a double-conversion receiver having a crystal-controlled first conversion stage. The 0.525 to 3 MHz RF amplifier cuts in between the first and second IF amplifiers to provide MW/BC reception. The 88 to 108 MHz receiver has its own FM detector and is switched directly into the audio amplifier. The SW sections have AM and product detectors and a BFO, permitting reception of both AM and SSB signals. The output of any of the tuning oscillators is fed, when selected, into a separate counter circuit which is used for

(Continued on page 86)

DXing The End of the World

Catch those rare signals from the tip of South America

BY C. M. STANBURY II

NO, WE'RE NOT TALKING ABOUT World War III. This article is about that part of Latin America which extends so far south we encounter winter, snow and Arctic conditions. It includes the Spanish-speaking nations of Chile and Argentina as well as the British-owned Falkland Islands. Stations there are an interesting mixture of intrigue and very rare DX. Included is a list of Argentine and Chilean shortwave stations, with frequencies, potential logging times and times of broadcasts in English.

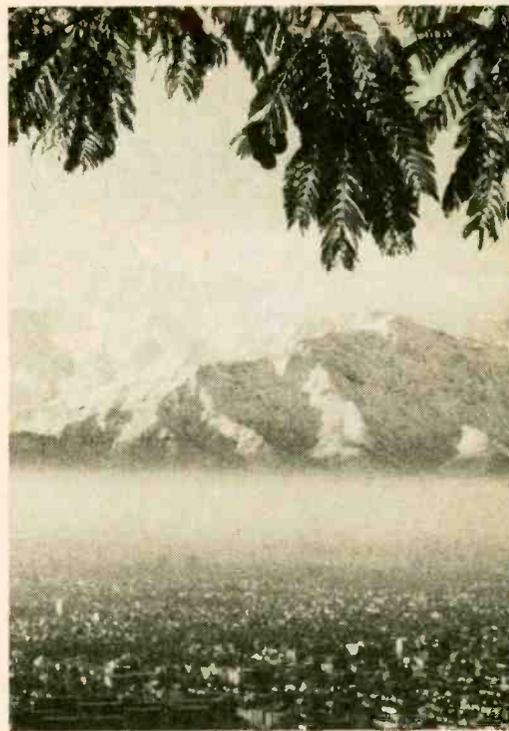
Chile. Let's start with the intrigue. In September, 1973 the duly elected but Marxist government of Salvador Allende was overthrown by a right-wing military coup. During the fighting, at least a couple of pro-Allende broadcast transmitters were destroyed and their frequencies taken over by new, apparently higher-powered, military broadcasters. Shortly thereafter Chile's new military government put on the air a number of very strong jammers aimed at Radio Havana, Radio Moscow etc. All of this clearly suggests the use of very sophisticated portable equipment which would have been provided to the generals by outside interests prior to the coup. It is known that at least one portable broadcast station was used by anti-Allende forces in 1972, prior to the coup.

By now presumably all the portables have been replaced with permanent installations. The jamming has ceased, but the international service, La Voz de Chile, continues to provide good reception in North America. Incidentally, before the coup this nation's largest broadcaster also called itself La Voz de Chile—a privately owned operation which reportedly became pro-Allende. English is broadcast by the present Voice of Chile several times a day. Although frequencies are constantly

Tranquil scenes like this one belie the turmoil that is ever-present, just below the surface, at the tip of South America—the "end of the world." The SWL is treated to a first-hand account of the region.

changing, you might try 17,800 kHz at 1830, 15,410 kHz at 1830 and 2030 and 11,765 kHz at 2130, 2300 and 0030 (EST).

The Chilean government's home service, Radio Nacional, is carried by a network of BCB stations which stretches



throughout the length of Chile. However, a shortwave relay on 6190 kHz can sometimes be heard at 0600 S/On. Radio Nacional programs are also occasionally received during evening on 6150—a transmitter which, ironically, once belonged to the original Voice of

COMPANIA CHILENA DE COMUNICACIONES, S. A.
 CADENA RADIAL "LA VOZ DE CHILE"
 GERENCIA GENERAL VALPARAISO ICHILEL - CASILLA 37-V

TARJETA DE VERIFICACION

Valparaíso, Febrero 23, 1962.

Confirmamos su recepción de fecha Febrero 12, 1962,
 de nuestra Emisora CB 73, Radio Cooperativa, Valparaíso,
 en la frecuencia de Onda Larga en 730 Kc/s, la que está
 correcta y conforme a la programación de ese día. (Special "DX"
 Programa, from 4,36 AM to 4,46 AM, hora chilena).
 Aimos amigos

CIA. CHILENA DE COMUNICACIONES, S. A.

 **RAE**
 RADIOFUSION ARGENTINA AL EXTERIOR

LRA
 RADIO NACIONAL

Agradeco Your kind letter
 1-VII-58 - Your reception
 port of 24-II-58, was very good

Radio NACIONAL FRECUENCIA 870 - KC/S
 POTENCIA 100 KW

PALACIO DE CORREOS BUENOS AIRES
 REPUBLICA ARGENTINA

QSL cards from La Voz de Chile, like this one from the early 1960s, have been rare since the military junta came to power.

Argentina's international radio service, RAE, carries English-language broadcasts several times weekly, and is easily tuned in.



Picture Credit CORFO

Chile. If you can hear Radio Nacional on 6150, tune down to 6135 and try for R. Universidad further south at Concepcion. Radio Universidad, a college station, was another broadcaster seized.

Chilean shortwave is still in a state of flux. There are still privately-owned stations in Chile, and some have relays listed on the 31-Meter band. The status of these transmitters is unknown, but try for Radio Agricultura on 9630 kHz at around 0500. Similarly, Radio Nacionala relays have been reported in the past on 11,720 and 15,110 kHz during early AM hours however, the current service is uncertain.

Argentina. Although this nation is also dominated by the military, and the

shortwave scene is comparatively stable—Argentina's three most prominent private stations (Radio El Mundo, Radio Belgrano and Radio Splendid) were "nationalized" many years ago—its political situation is really much more chaotic than Chile's. In fact, at one point the Chilean government seemed to be jamming Argentina's Radio Nacional on 6060 kHz. Part of the problem in relations between Chile and Argentina was caused by some disputed islands at the continent's southern tip. This dispute has now supposedly been settled satisfactorily.

The Buenos Aires government's international service calls itself Radiodifusora Argentina al Exterior (RAE—

pronounced "rye" on the air). It has three English transmissions each weekday, at 1800 for Europe on 11,710, and at 2200 and 0100 EST for the Americas on 9690 kHz. RAE is heard almost as easily as La Voz de Chile. As previously indicated, the home service, Radio Nacional, broadcasts on 6060 where NA DXers sometimes log it in the early evening and at 0400 S/On. These frequencies are all transmitted from Buenos Aires, but there is also a Radio Nacional relay at Mendoza, near the Chilean border, on 6180 kHz.

Meanwhile, the three aforementioned nationalized stations just happen to be the key outlets for Argentina's major commercial networks. However, programming from smaller networks is relayed to outlying affiliates via short-wave point-to-point (telephone) links. One such transmitter is heard on 5882 kHz relaying Rivadavia. At times its strength is considerably greater than one would expect from a SW phone link. Two other p-t-p transmitters, on 3245 and 6080 kHz, have been reported relaying Radio Provincia de Santa Cruz, Rio Gallegos near Argentina's southern tip. However, one cannot always be certain where such link transmitters are located: 3245 and 6080 kHz may not actually be at Rio Gallegos, but further north.

Falkland Islands. There is no question about the location of the Falkland Islands Broadcasting Service which transmits from Port Stanley on East Falkland Island—approximately 250 miles east of Rio Gallegos, Argentina. Currently a British possession, the islands are also claimed by Argentina. Almost none of the Falklanders, all of whom are English-speaking, want to become part of Argentina. At the moment this territorial dispute is still relatively peaceful.

Even when it operated on 75 Meters, FIBS (which many DXers consider a very appropriate abbreviation) was extremely difficult to hear in the northern hemisphere and reports of reception always provoked controversy within the DX subculture. After FIBS moved to 2 MHz (actually MW territory) in the 1960s there were no proven instances of reception. Then in 1978 FIBS, now on 2370 kHz, began sharing the transmitter of Stanley Aeradio and several expert DXers have since heard them.

Time to listen is between 1900 and 2030 EST. Unfortunately, since switching transmitters, the station has stopped answering DX mail. So if you hear them, it would be a good idea to have a tape recorder handy. Of course, Falklands' QSL policies could change at any time. ■

ARGENTINE AND CHILEAN SHORTWAVE STATIONS

kHz	Station	Time (EST) & Notes
5882	Radio Rivadavia, Buenos Aires	Late afternoon & early evening, p-t-p link
5985	Radio Splendid, Buenos Aires	0400 S/On & early evening
6060	Radio Nacional, Buenos Aires	0400 S/On & early evening
6090	Radio Belgrano, Buenos Aires	0400 S/On & early evening
6120	Radio El Mundo, Buenos Aires	All night
6135	Radio Universidad, Concepcion	0600 S/On & early evening
6150	Radio Nacional, Santiago	Evenings
6180	Radio Nacional, Mendoza	0400 S/On & early evening
6190	Radio Nacional, Santiago	0600 S/On
9690	RAE, Buenos Aires	English at 2200 & 0100 weekdays
9705	Radio El Mundo, Buenos Aires	Early evening
11,710	RAE, Buenos Aires	English to Europe at 1800 weekdays
11,765	La Voz de Chile, Santiago	English at 2130, 2300 & 0030
15,410	La Voz de Chile, Santiago	English at 1830 & 2030
17,800	La Voz de Chile, Santiago	English at 1830, 2030 & 2130

Microchess 1.5 for the TRS-80

Your first step towards
mastering the game of kings

BY RONALD H. BOBO

SOME HOBBY COMPUTERS can do truly amazing things with just a few K of memory, while others seem to require banks of floppy disks to perform what seems like the simplest of tasks. Of course, it's not really the computer's fault; some programs, such as listings, require a great deal of memory. It's not all memory, however. Much of the success or failure of a program depends on the talent of the programmer. The programmer must get the computer to do more with shorter, more concise instructions.

The Personal Software Company must have some skilled programmers because they have managed to squeeze a pretty good chess program into the TRS-80's 4K RAM with either the Level I or Level II BASIC. The program is called Microchess 1.5.

Within Limits. While adequate for many purposes, 4K is not much room for a chess program, and it is no reflection on the TRS-80 or the program that this limits the skill level of the machine. Like most chess programs, Microchess 1.5 examines all the possible moves on the board before deciding what move to take. Its intelligence is mostly a matter of how many moves ahead it looks. The operator can tell the machine to choose one of three progressively more difficult levels called: IQ 1, IQ 2 and IQ 3. At IQ 1 and 2, the program will overlook some fairly common traps, but at IQ 3, unless you're a real chess buff, it will give you a run for the money.

The only non lack-of-memory related problem we found was when trying to capture a pawn *en passant*. We've attempted this a couple of times when playing White. The Black pawn is removed from the board and the white pawn is moved to the proper square, but Black is cheated out of a turn! White moves twice in succession. Not exactly a fair shake for the machine.

Most of the staff are strictly amateurs at chess, but it didn't take long to stumble onto a series of moves which

allowed a win in seven, playing at IQ 2. It goes like this:

White	Black
1-KP-K3	KP-K4
2-QKtP-Kt3	KB-QB4
3-Q-KR5	KKt-KB3
4-Q-K5 (Check)	Q-K2
5-Q-KKt5	O-O (Castles on King side)
6-QB-QKt2	KKt-K5 (Invites a Queen trade)
7-Q-KKt7 (Mate)	

Loading. Microchess is a Z-80 machine language program, but loads without the T-Bug monitor. On Level I machines, it's just like BASIC. Type CLOAD and press ENTER. The asterisk which indicates proper loading will flash on and off at a much slower rate than it does while a BASIC program is being loaded, but fear not. This is normal for machine language. At the end of the load, instructions will be printed out on the CRT. The tape recorder will stop automatically if your REM plug is inserted.

Level II machines load this program a little differently. First, type SYSTEM followed by the ENTER key. The *? prompt of the Level II machine language loader should appear. Now type CHESS followed by ENTER. Flashing asterisks should appear briefly in the upper right corner of the screen, followed by another *? prompt. If you don't see the flashing asterisks, the recorder volume is probably too high; lower the setting slightly and try again. If a C appears in the upper right corner, a "check-sum" error has occurred, and the volume is probably too low. Raise the volume a little and try again.

If all looks good, type a / followed by ENTER. Now, in just a jiffy, two flashing asterisks should appear in the lower right corner of the CRT. Again, these asterisks will flash slower than they do for a BASIC program.

Playing. This program contains a graphics driver, and the board is displayed on the CRT at all times. Algebraic notation is used to enter moves.



CIRCLE 85 ON READER SERVICE COUPON

The files are lettered from A to H, starting from White's left, and numbered from 1 to 8 starting from white's back rank. Moves are entered by typing the number of the square your piece is on, followed by a hyphen and the number of the square to which you are moving. For example, to move the White King's pawn two spaces forward, you would type E2-E4. Other notations are used for special situations such as castling or setting the board up in a particular way to work out a chess problem. These are covered extensively in the instruction booklet which comes with the cassette.

Microchess plays at three different skill levels which are labeled IQ 1, 2 and 3. IQ 2 always comes up at the start of a new game. To change, simply type IQ=1 or IQ=3, followed by ENTER. As the IQ numbers get higher, Microchess "thinks" for a progressively longer time before each move, thereby playing a tougher game. At IQ 3, a good game can easily last over an hour.

"Because it is a gentleman," says the instruction booklet, "Microchess has given you the White pieces to start the game." To play Black, type X followed by ENTER. This will exchange the White and Black pieces on the board. Next, type P then ENTER and the computer will make the first move. In fact, if you keep entering X followed by P, the computer will move for both White and Black, effectively playing a game against itself.

Conclusion. Despite the minor flaws noted previously, Microchess 1.5 has to be rated as a very good buy. The many hours of enjoyable recreation this program affords the user are well worth the \$19.95 price. After all, you can blow that much on a trip for two to the movies, with a stopover at the local burger bar afterward.

For more information on this and other Microchess software, contact: Personal Software, Inc., 592 Weddell Drive, Sunnyvale, CA 94086, or circle 85 on the reader service card. ■

Electronics Notebook

Practically every electronic circuit utilizes the property of capacitance, therefore making it one of the most important concepts you will have to master in your study of electronics

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.

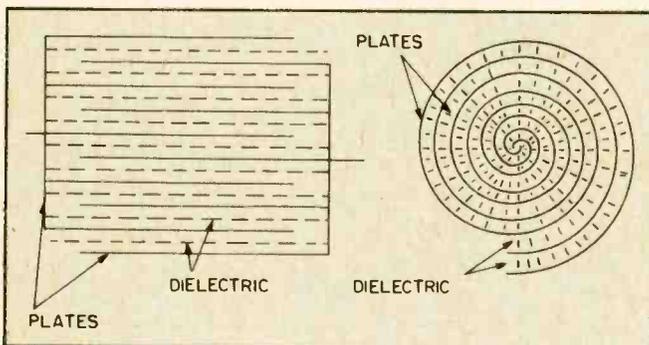
WHAT IS CAPACITANCE?

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.

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 appears 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.

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 layer is called the **dielectric**.

STACKED AND ROLLED CAPACITOR TYPES



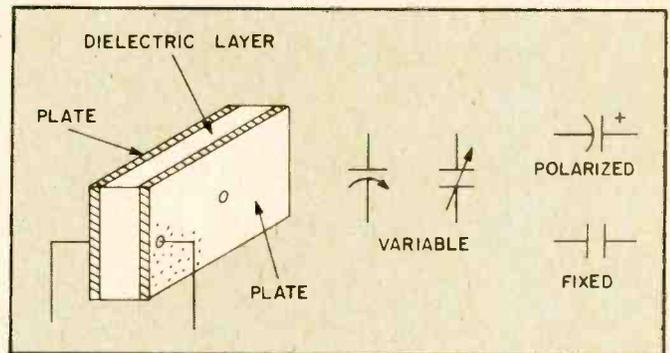
All capacitors have these two plates and a separating layer. In practice, the plates and dielectric are often stacked or even rolled into a compact form. Sometimes the dielectric is a paste or a liquid instead of a solid.

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,

CIRCUIT SYMBOLS AND CORRESPONDING PARTS



and which opposes the voltage of the battery.

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

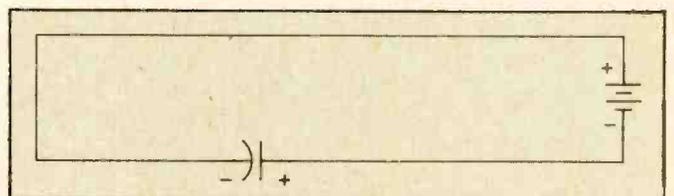
QUESTIONS

1. Name two differences between capacitance and inductance.
2. Draw a circuit diagram of a capacitor connected across the terminals of a battery.
3. Explain what happens when you disconnect the battery terminals from a charged capacitor and place a wire across the leads of the capacitor.

ANSWERS

1. Capacitance opposes a change in voltage while inductance opposes changes in current. Capacitance blocks DC while inductance does not.
2. Your circuit diagram should look like this.

ANSWER TO QUESTION 2



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**).

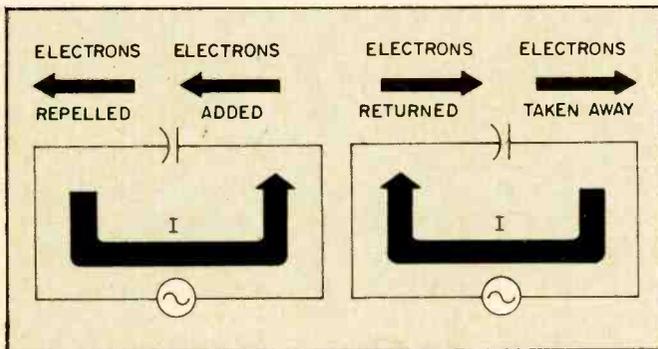
HOW DOES CAPACITANCE AFFECT AC?

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.

AC THROUGH A CAPACITOR



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**.

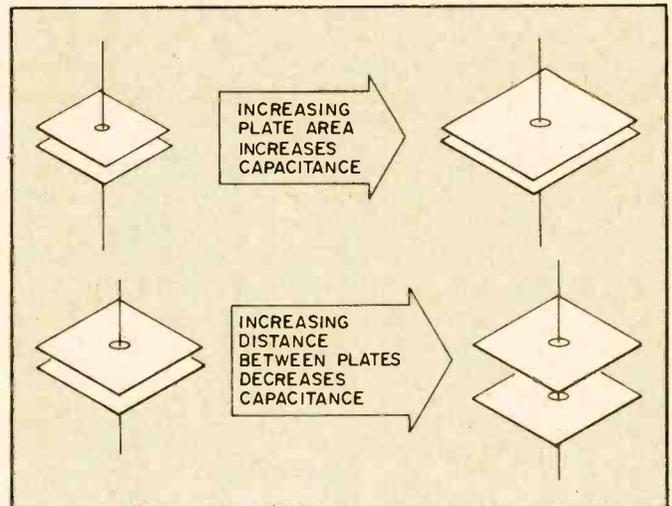
A7. Current will flow through a capacitor only when **voltage** is changing.

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

PHYSICAL FACTORS AFFECTING CAPACITANCE



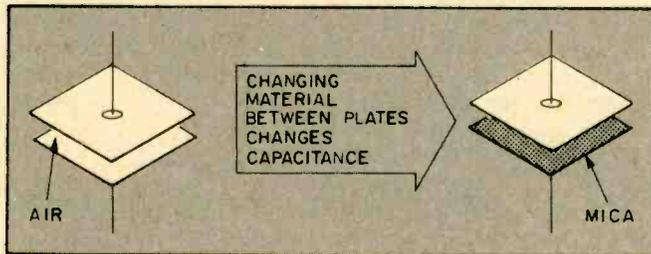
and the positive charges on the other side is greater. It is, of course, necessary to keep the plates sufficiently separated so that the charge does not jump through the dielectric, possibly damaging the capacitor.

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 constant of 1, glass about 5, and mica 2.5 to 6.6.

DIELECTRIC FACTORS AFFECTING CAPACITANCE



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.

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**.

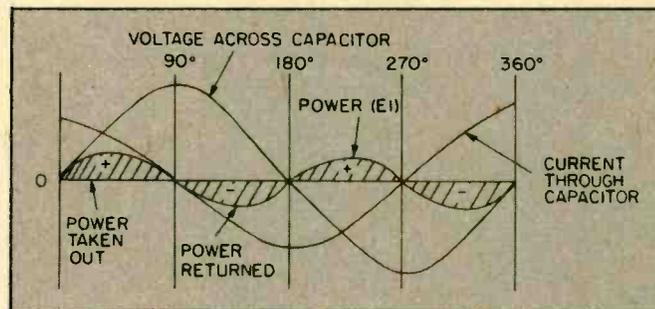
POWER

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

ENERGY STORAGE CYCLE



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.

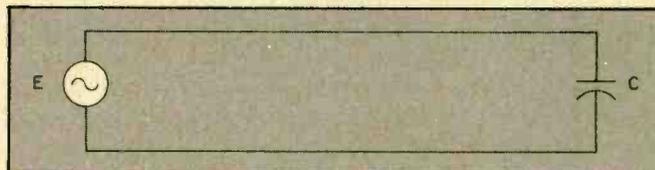
CAPACITIVE REACTANCE

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 present at all in the circuit.

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

RESISTANCE-FREE CIRCUIT



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

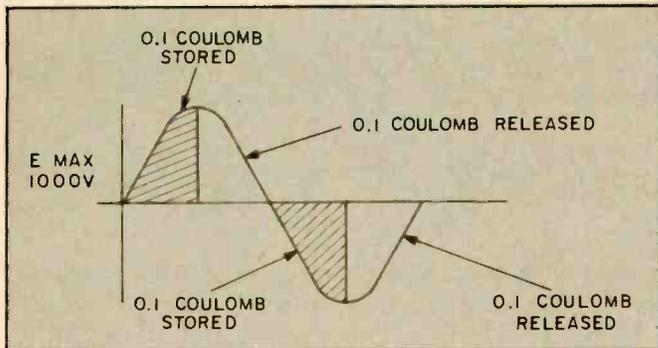
- A11. 1,000 volts \times .0001 farad = 0.1 coulomb

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,

Electronics Notebook

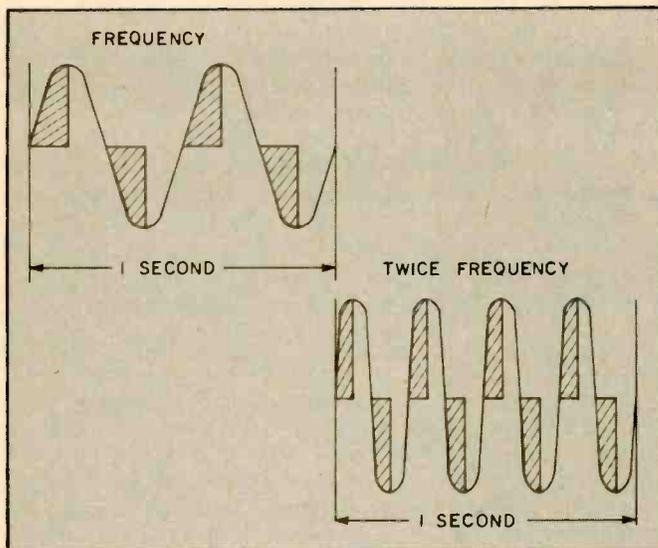
we must have twice the current to supply this same amount of energy.

ENERGY STORAGE POTENTIAL



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.

POTENTIAL VERSUS FREQUENCY



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:

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

where,

f is the frequency in Hz,

C is the capacitance in farads.

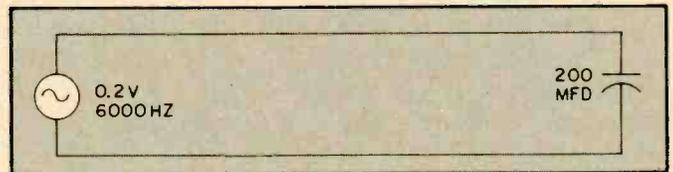
Capacitive reactance can be used in calculating current in a purely capacitive circuit by Ohm's law.

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

QUESTIONS

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

CIRCUIT FOR QUESTION 12



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

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

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

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

This series is based on material appearing in Vol. 2 of the 5-volume set, BASIC ELECTRICITY/ELECTRONICS, published by Howard W. Sams & Co., Inc. For information on the complete set, write the publisher at 4300 West 62nd St., Indianapolis, Ind. 46268.

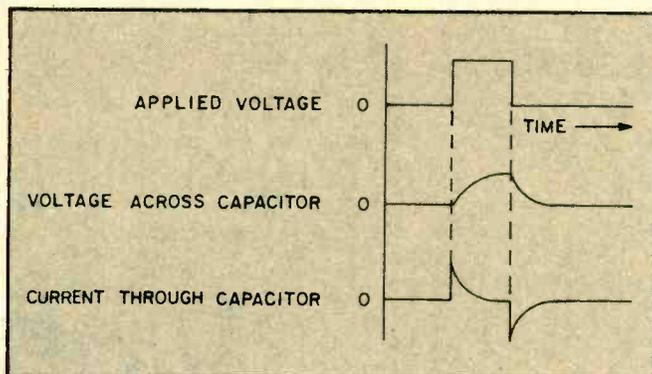
$$A13. I = \frac{E}{X_c} = \frac{0.2}{0.133} = 1.5 \text{ amps}$$

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

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.

CAPACITANCE VERSUS TIME



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.

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.

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.



CB Spectrum

(Continued from page 65)

particularly in budget transceivers).

Performance. Though the TRC-420A is small in size and price, it's real big in performance. I measured sensitivity as $0.6 \mu\text{V}$ for a 10 dB signal plus noise to noise ratio (the standard test).

Selectivity measured 66 dB adjacent channel rejection, a level of performance usually expected from higher-priced equipment. The AGC action measured 8 dB; not great, but not poor.

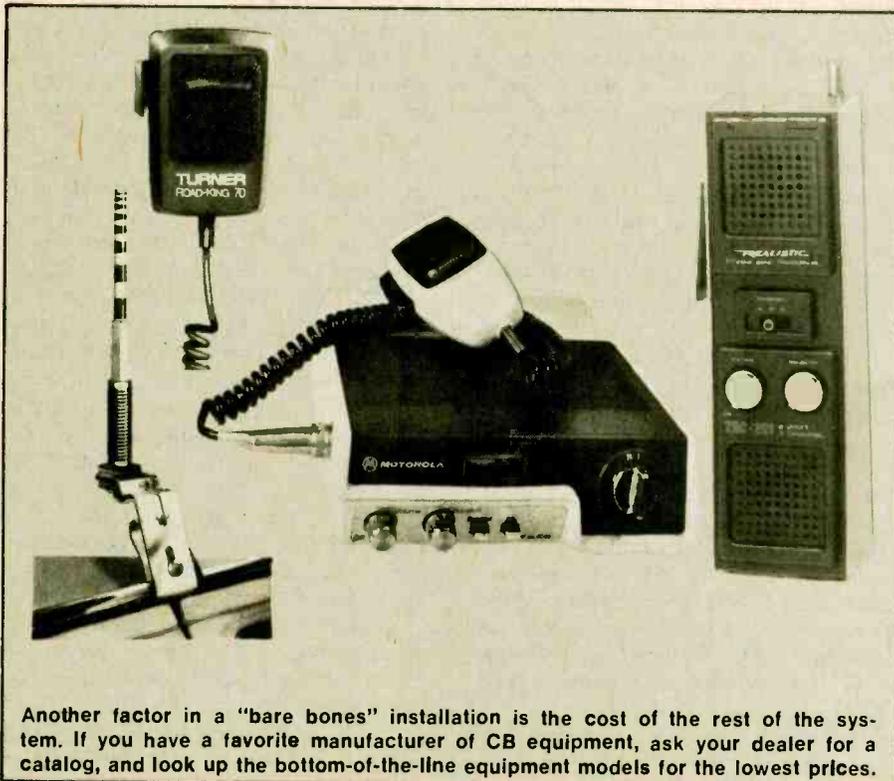
AGC action represents the change in speaker volume when the input signal to the antenna is increased from 2 to 10,000 μV —a change of 74 dB. This range synthesizes what occurs when listening to a weak signal, and then having a strong signal come on the channel. If there was no automatic gain control, the strong signal would literally blast the cone out of the speaker. What actually occurs is that the 74 dB signal variation is compressed by the AGC to only 8 dB, a ratio easily accommodated by the ear. An ideal AGC would provide 0 dB (no) variation; the strong signal would come out of the speaker at the same volume level as the weak signal. This, of course, is impossible to attain. In actual practice, an AGC action of 2 to 10 dB is "acceptable."

Though the S-meter scale on the meter is calibrated, the readings are

relative, meaning there is no fixed value per S-unit. S9 on the scale represents an input signal level of $50 \mu\text{V}$. The TX POWER meter calibration consists of black and red segments. If the meter reads in the black segment when the transmitter is keyed, you can assume all is okay. If the meter indicates "high," in the red segment, you can make a safe assumption it is caused by a high SWR on the antenna system, generally caused by a defective transmission line or antenna.

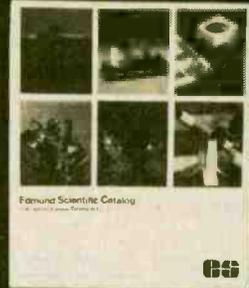
The transmitter delivered 3.8-watts RF output to a 50-ohm load. The modulation was limited to 100%. Microphone sensitivity for 100% modulation measured -20 dB, which is right "on the mark" for an average voice level. This is the way it should be, even though many transceivers have so much mike sensitivity they can pick up a flea's whisper at 50-yards. The trouble with excess microphone sensitivity is that it picks up all extraneous noises between the mike and the flea. The modulation limiting also checked out a winner. Actually, it is compression rather than limiting, which keeps distortion at a minimum even when shouting into the mike.

All in all, the Realistic TRC-420A delivers a lot more performance than implied by its \$79.95 price tag. It's an outstanding value for the CBER on a really tight budget. In fact, it's an outstanding value even if you aren't on a tight budget. ■



Another factor in a "bare bones" installation is the cost of the rest of the system. If you have a favorite manufacturer of CB equipment, ask your dealer for a catalog, and look up the bottom-of-the-line equipment models for the lowest prices.

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DX Central

(Continued from page 16)

more than 1,300 airable 'cuts,'" Ron notes. "We try simply to have fun on the air, while presenting some interesting facts behind the music played. WDAB is non-political, non-public affairs, non-news oriented, non-biased for or against any country or government; it is exactly the opposite of what you would expect to find on conventional shortwave."

When we last heard from Ron, he noted that WDAB had been heard by listeners in 19 states and Canada, at distances up to about 2,000 miles from Daytona Beach. But in an attempt to push the tiny 50-watts further, Ron says the station may move up to 13 meters. WDAB has no firm schedule, except that it operates be-

Cover to Cover

(Continued from page 27)

ments by Dr. Peter R. Rony, techniques are presented in such a way that the principles can be applied to other PPI chips by students, scientists and engineers. All of the modes of operation are detailed, and a clear explanation of data transfer processes, flag sensing, bit testing, and similar topics is included. Experiments reinforce the concepts of each chapter, from simple input and output ports through complex master-slave micro-computer configurations. Published by E&L Instruments, Inc., 61 First St., Derby, CT 06418. ■

Hi-Fi Reports

(Continued from page 28)

and room acoustic checks, and even comes with a test record. The response is indicated by an LED "screen" that can be read to an accuracy of 1 dB at center frequencies of 30, 63, 125, 250, 500, 1000, 2000, 4000, 8000 and 15000 Hz.

A spectrum analyzer is becoming the "in" thing on some components. JVC includes one on their KD-A7 cassette deck and their SEA-80 equalizer. Other companies such as Crown, Optonica and Audio Control also have components with spectrum analyzers in their line up.

Within the next few years, spectrum analyzers are going to become as common on moderately-priced components as power meters are ■

tween 7 and 9 PM local time, or 0000 and 0200 GMT, on 6,213 kHz.

The station has a QSL card it sends to listeners reporting its signal. The address is: WDAB c/o The Free Radio Campaign, Route 2, Box 542, Wescosville, PA 18106.

Ron Kay and co-disc jockey Jerry Kay seem aware of the potential problems their unlicensed operation may cause them, and they say they would much prefer to operate legally with a license, if it were possible. "Here's to better reception," Ron adds jauntily, "if we're still around."

BBC Suffers. From time to time over the last several years, threats have been sounded that could hamper one of the world's best and best known broadcasting services, the British Broadcasting Corp. (BBC)

Not surprisingly, in this era, the threats were financial. The British government has talked for a few years of cutting back on the grant-in-aid it provides for the shortwave foreign broadcasting. Last fall, however, push came to shove and the British government became deadly serious about a cutback in funds—some 2.7 million Pounds Sterling.

The first word was that seven foreign language services would be totally axed—French services to Europe and Africa, Spanish services to Spain, and all programs in Italian, Greek, Turkish, Burmese and Maltese. Although, as proposed, the famed World Service would be unchanged, the cuts in the language services would have, in the words of a BBC spokesman, dropped Great Britain from the higher rungs of the international broadcasting league. Some 100 BBC staff members would have lost their jobs as a result of the money cut. That, apparently was the biggest factor in changing the government's mind. In late November, it was determined that the seven foreign language services—and the hundred BBC staffers—would stay. What will be cut in 1980 is capital spending on new transmitters.

Initially, at least, this will be scarcely noticed by the SWL. The big question remaining, however, is whether the budget cut is only for 1980, or if it will continue year after year, thus halving the money promised over a five year period. If so, then there may be problems that are definitely noticeable to the shortwave DXer. The capital improvement program, approved several years ago but started in 1979, calls for the replacement of aging SW transmitters

in England, an increase in power for four transmitters at the Cyprus relay base and a completely new BBC SW relay facility in the Seychelles Islands in the Indian Ocean, plus satellite "feeds" to various relay sites outside Great Britain. So, for the moment at least, programming problems seem to have been averted, but the long range situation remains clouded.

WARC '79. In an earlier column, I mentioned the World Administrative Radio Conference (WARC) in Geneva, Switzerland, a gathering of representatives from 154 nations meeting to establish the frequency allocation ground rules that will govern broadcasting, especially shortwave, until the year 2000. Earlier, shortwave fans were worried that WARC '79 might produce some rule changes in frequency allocations that might cause serious problems for DXers. The ten-week conference came and went, and it seems the results were hardly as devastating as first predicted by the pessimists nor as beneficial as hoped by the optimists.

It seems as though there will be no changes in the shortwave broadcasting frequency alignments below the 31 meter band. In the higher frequencies, there will be a total of 850 kilohertz of band space opened up to the international broadcasters.

Here's where you can look forward to increased band space: The upper end of the 31 meter band will be extended from 9,775 to 9,900 kHz. Fifty more kHz will be added to 25 meters, 11,650 to 11,700 kHz on the lower end of that band, and 75 kHz to the top end, 11,975 to 12,050 kHz. A completely new international SW broadcasting band will be created between 13,600 and 13,800 kHz. The following new segments will be added to the 19, 16 and 13 meter bands respectively: 15,450-15,600, 17,550-17,700, and 21,750-21,850 kHz.

Bandsweep. Frequencies in kHz; times in GMT—4,770. ELWA, Monrovia, Liberia, a nice catch. This is a West African missionary station that has been reported lately around 0630 GMT and in the afternoons until 2300 sign off . . . 4,794. A new one that popped up some months back, causing a bit of a stir among DXers, was Radio Apintie, Parimaribo, Surinam.

(Credits: Eric Miller, MA; Larry Cunningham, OH; Ralph Perry, PA; Harold Sellers, Ont.; Darryl Holland, NY; Mike Simaschko, WI; J. Findlater, CA; North American SW Association, Box 13, Liberty, IN 47353.) ■

Home Recording

(Continued from page 35)

signed for professional or home studio use is the best way to go. There are many excellent reel-to-reel recorders designed by companies such as Otari, TEAC, and AKAI. At the moment, there is only one cassette-based multi-track machine, the *Portastudio 144* by TEAC. This is a rather unusual product in that despite the fact that it uses cassettes, all resemblances to a conven-

Suggested Reading

Home Recording for Musicians by Craig Anderton (Music Sales Corporation, 33 West 60th Street, New York, NY 10023). Oriented towards beginners

The Multitrack Primer by Dick Rosmini (Teac, 7733 Telegraph Road, Montebello, CA 90640). Oriented towards beginners/intermediates.

Handbook of Multichannel Record-

4 tracks simultaneously.

However, just as audiophiles prefer to go for component systems where each part of the system may be chosen according to need and budget, advanced home recording studios go beyond the "all-in-one" studio idea and use individual recorders and mixers. 8-track machines are getting more common as they become less expensive. However, while a good 4-track will cost anywhere from \$1000 to \$3000, the 8-track will cost anywhere from \$3000 to \$5000.

Where do You go From Here? Al-

ing by Alton Everest (TAB Books, Blue Ridge Summit, PA 17214). Gives much background information on studios.

Modern Recording Techniques by Robert Runstein (Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, IN 46268). More technical than the first 3 books; good for those who understand the basics, but want to know more.

tional cassette recorder stop there. For one thing the tape speed is 3.75-inches-per-second, twice the speed of a standard cassette deck. This allows for greater fidelity, lower noise, and improved high frequency response. Additionally, the head is specially configured to allow recording up to 4 individual tracks on the cassette. The only limitations are that you cannot record on all

though it can take lots of money to set up a studio, it can also take comparatively little. The author's first studio cost \$1500—\$1000 for the 4-channel deck, \$300 for a cassette deck for mix-down, and \$200 for the (homebrew) mixer. So it is possible to get involved in home recording without mortgaging your future, especially if you start off with some budget techniques. ■

Digital Gauge

(Continued from page 52)

leads, either of whose presence in close proximity to the coax could cause deleterious effects.

Locate a point in the firewall where accessory wires are passed through grommets to the passenger compartment, and feed the coax through at this point. Should you be unable to locate or utilize existing holes, locate a point on the firewall clear of obstacles both in the engine compartment and passenger compartment (behind the dash) and drill a 3/8-inch hole through. After passing the coax through the hole, apply silicone cement to the area to provide a weatherproof seal. Water has a nasty habit of travelling along lines, through holes, and onto irreplaceable carpets and ruining them if sufficient precautions are not taken.

Trim any excess coax so that it runs to the gauge in as direct a manner as possible from the firewall, and install P1. Plug P1 into jack J1, and connect the power leads (preferably to the horn

fuse for V+, and to a good chassis point for ground).

Conclusion. Some of you are no doubt questioning the wisdom of center-drilling so fragile a component as a manifold bolt, especially on older cars, where the original bolts may be either rust or heat-seized. If, when removing the original bolt to replace it with the probe-carrying bolt, you should happen to break the bolt off, do not become alarmed. This happens commonly during carburetor and gasket overhaul and replacement at car dealers and service stations. They are capable of drilling the remaining piece of the bolt out for you quite easily, leaving you free to install the new bolt.

We have selected this method of probe installation to insure the most accurate readings allowable. Other methods, such as insertion of the probe in the coolant itself, would tend to violate the pressure integrity of the car's systems, leaving open the possibility of leakage and fluid loss at a later time. Additionally, encasing the probe in the necessary waterproofing material would result in an unacceptable loss of sensitivity. ■

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400. *Continental Specialties* provides new product info in its catalog of Testing and Design Instruments. A Digital Capacitance Meter and Tri-Mode Comparator are just some of the featured projects.

399. "Firestik" *Antenna Company* has introduced a new and informative product catalog on top-loaded, helically wire-wound antennas and mounts.

398. *Hamtronics, Inc.* has announced a new model R110 VHF AM Receiver Kit which employs an AM detector and a dual-loop agc system. A complete catalog is yours for the asking!

397. *Instant Software, Inc.* is offering a special holiday catalog for all kinds of year 'round software package gift-giving, as well as their regular microcomputer catalog.

396. *Creative Computing's* first software catalog of various education and recreation simulation programs as well as sophisticated technical application packages is available now.

395. *OK Machine and Tool Corporation* features the new PRB-1 Digital Logic Probe on the cover of its latest catalog of wire wrapping and other electronic assembly tools.

394. *KEF Electronics Ltd.* is offering two speaker systems in kit form at a significant cost-savings. The Model 104aB and the Cantata can be easily assembled and may be auditioned before purchasing.

389. You can't buy a bargain unless you know about it! *Fair Radio Sales'* latest electronics surplus catalog is packed with government and commercial buys.

388. SWLs need *Gilfer's* Shortwave Mail Order Catalog for economy one-stop armchair shopping. From top-notch rigs to reporting pads, Gilfer supplies all your hobby needs.

327. *Avanti's* new brochure compares the quality difference between an Avanti Racer 27 base loaded mobile antenna and a typical imported base loaded antenna.

362. A new catalog crunched full of military, commercial and industrial surplus electronics for every hobbyist is offered by *B&F Industries*. 44 pages of bargains you've got to see!

384. *B&K-Precision* has issued BK-10, a condensed catalog describing their oscilloscopes, semi-conductor testers as well as test instruments for CB, radio and TV repair.

310. *Compumart Corp.*, formerly NCE, has been selling computers by mail since '71, and is offering a 10-day return policy on many items featured in their latest catalog.

322. *Radio Shack's* latest full color catalog, "The Expanding World of TRS-80," is out now, packed with up to the date information on this microcomputer. Specifications for the new Model II as well as the Model I are included.

386. If you're looking for books on computers, calculators, and games, then get *BITS, Inc.* catalog. It includes novel items.

335. The latest edition of the *TAB BOOKS* catalog describes over 450 books on CB, electronics, broadcasting, do-it-yourself, hobby, radio, TV, hi-fi, and CB and TV servicing.

338. "Break Break," a booklet which came into existence at the request of hundreds of CBers, contains real life stories of incidents taking place on America's highways and byways. Compiled by the *Shakespeare Company*, it is available on a first come, first serve basis.

345. For CBers from *Hy-Gain Electronics Corp.* there is a 50-page, 4-color catalog (base, mobile and marine transceivers, antennas, and accessories).

393. A brand new 60-page catalog listing *Simpson Electric Company's* complete line of stock analog and digital panel meters, meter relays, controllers and test instruments has just come out.

385. Amateur Radio buffs and beginners will want the latest *Ham Radio Communications Bookstore* catalog. It's packed with items for the Ham.

373. 48-page "Electronic Things and Ideas Book" from *ETCO* has the gadgets and goodies not found in stores and elsewhere.

382. Buy by the dozens in *Long's Electronics* super "Ham Radio Buyer's Guide." Good reading if you're in the market for a complete station or spare fuses.

383. If you're a radio communicator, either ham, SWL, scanner buff or CBER, you'll want a copy of *Harrison Radio's* "Communications Catalog 1979." Just what the shack book shelf needs.

380. If your projects call for transistors and FETS, linear and digital ICs, or special solid-state parts, then look into *Adva Electronics'* mini-catalog for rock bottom prices.

301. Get into the swing of microcomputer and microprocessor technology with *CREI's* new Program 680. New 56 page catalog describes all programs of electronics advancement.

305. A new 4-page directional beam CB antenna brochure is available from *Shakespeare*. Gives complete specs and polarization radiation patterns for their new fiberglass directional antennas.

371. Your computer system needn't cost a fortune. *Southwest Technical Products* offers their 6800 computer complete at \$395 with features that cost you extra with many other systems.

306. *Antenna Specialists* has a new 32-page CB and monitor antenna catalog, a new amateur antenna catalog, and a complete accessory catalog.

377. *John J. Meshna, Jr., Inc.* has a super-saver catalog out (SP-16) featuring walky talkies, police radar detectors, vacuum pump compressors and other fascinating products to choose from.

330. There are nearly 400 electronics kits in *Heath's* new catalog. Virtually every do-it-yourself interest is included—TV, radios, stereo and 4-channel, hi-fi, hobby computers, etc.

392. The opening of the new Software of the Month Club has been announced by *Creative Discount Software*, which is giving out membership enrollment applications now. The Club plans to have separate branches for users of the Apple II, TRS-80, Ohio Scientific, Exity, Pet and CP/M based systems.

390. *Whitehouse & Co.*, your "hard to find parts specialist," offers over a dozen parts and kits in their latest catalogue, featuring an entire section on gunplexers for Amateur Radio buffs.

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

320. *Edmund Scientific's* catalog contains over 4500 products that embrace many sciences and fields.

328. If you are into audio, ham radio, project building, telephones, CB or any electronics hobby you'll want *McGee's* latest catalog of parts and gadgets.

333. 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.

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Panasonic RF-4900

(Continued from page 71)

the digital frequency display.

Since each band of frequencies is covered by a separate receiver, there are special features to optimize reception for the signals normally encountered on each band. For example, one switch provides wide or narrow IF selectivity for FM reception, or wide or narrow selectivity for short-wave reception. Another switch provides a noise limiter for SW frequencies, while yet another switch provides for AM, CW (Morse code), or SSB reception on the SW bands. Similarly, an RF gain control only functions for AM/CW/SSB, and not for FM.

Operating Controls. In addition to the RF gain adjustment, there are controls for volume, bass, treble, BFO pitch, and antenna trimmer. Additional switches are provided for power, panel lights off (tuning dial and S/battery meter), and digital display on-off.

A relatively large (3.5-inch) speaker is mounted on the left of the front panel and faces forward (for best sound quality). Under the speaker are three mini-jacks for connection of an external speaker or headphones, a tape recorder, and an auxiliary signal speaker or headphones, a tape recorder, and an auxiliary signal source such as a tape recorder (the receiver then functions as an amplifier).

Located under the digital readout is a thumb-adjustment labeled *cal* that also requires an explanation. Though the RF-4900 has a digital frequency display, the tuning is controlled by tuneable local oscillators, not a digital synthesizer. The counter reads the FM oscillator directly, so its FM readout is correct. The BC stations are tuned directly by a local oscillator which has negligible drift, so the digital readout is "correct." Though this same oscillator is used for 4 to 30 MHz, 3 to 30 has a crystal-controlled pre-mix, and since the crystals are not precisely on frequency, there has to be some way to correct the digital frequency display. This is where the *cal* control comes in. On the 3 to 30 MHz range, it is used to "zero" the digital display to 1 kHz accuracy. Simply tune in a station of known frequency and adjust the *cal* control for optimum reception—that's all there is to it.

Performance. It is one thing to build as much as is possible into a box, and it is quite another thing to get it all working together as a team without

birdies, whistles, and beeps. The Panasonic RF-4900 proves it can be done.

Sensitivity for 10 dB S+N/N (signal plus noise to noise) ratio from 3 to 30 MHz measured between 0.5 μ V and 1.0 μ V, the precise value depending on the frequency. This is somewhat better than the claimed worst-case sensitivity of up to 20.0 μ V. On FM, the input sensitivity for 300-ohm and dipole antennas measured 5 μ V for full limiting.

Summing Up. Overall, the performance and flexibility are noteworthy. But keep in mind the RF-4900 is especially tailored for the radio listener, and it really isn't a communications receiver geared for the Amateur. Don't try to get two-for-one by using the receiver for Amateur and SWL. You'll be unhappy on both ends. The RF-4900 is a notable performer for the SWL, and it is probably one of the best values in general-purpose SWL receivers.

The Panasonic RF-4900 is priced at \$549.95. It is supplied with an AC power cord, a set of "D" batteries, and clip-on wire antennas. For more information on the Panasonic RF-4900, contact Panasonic at One Panasonic Way, Secaucus, NJ 07094, or circle number 72 on the reader service coupon. ■

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INPUT/OUTPUT



BY HANK SCOTT

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
ELEMENTARY ELECTRONICS
380 Lexington Avenue
New York, NY 10017

Keep Clean

How can TV frequencies from a home receiver interfere with an AM radio? The frequencies on the TV are much higher than the AM radio.

—W.B., Waterberg, CT

Corona leakage from the high voltage circuit introduces considerable interference very much like a spark gap generator, auto ignition circuit, or faulty brush-type motor. I use a pocket AM radio to inspect my TVs. When the interference is high as the radio is brought near the unit, I know it's time to vacuum the TV set's innards. Be very careful when you do this, and turn the power off. Use only plastic vacuum gadgets and do not put your hands near the picture tube or high voltage lead. An artist's brush with long wood handle and stiff bristles may be used to loosen caked-in dirt. A clean up job inside reduces lots of RF noise outside. Also, a unit will run cooler without its insulating dust layer.

Many Ways to Go!

I have recently developed an interest in hobby computers/microprocessors and would like to take a home study course to get started. I am a graduate electrical engineer working in power plant construction, which requires frequent relocations. Can you suggest a course that will suit my needs, providing a good background in theory and application as well as offering good basic hardware around which I can build a system?

—R.M., Lewes, Del.

In every issue of ELEMENTARY ELECTRONICS you will find advertisements from National Radio Institute, National Technical Schools and Cleveland Institute of Electronics—all three are good educational institutions with many years of successful educational accomplishments. Write to them asking for details on their hobby computer programs. Also, check out the Heath Company, which has a good home study program course as well as equipment in kit and wired form. Radio Shack has the popular TRS-80, and many good books have been published on learning to use this equipment. Further, write to the major suppliers of personal computer equipment. They offer products for hobbyists and training manuals. Above all, keep reading ELEMENTARY ELECTRONICS and the popular computer magazines to

stay well informed on the happenings and trends in the hobby.

Find an Old Blade

Hank, I'm trying to locate a schematic diagram for a "razor blade" radio. I built one in 1951 when I was in the 8th grade, but I can't remember anything about it. Can you help?

—J.C., Dubuque, IA

Use any crystal radio circuit, except replace the crystal unit with a razor blade. Mount the razor on a board with a good electrical terminal attached to the blade. Do not solder! Then use a cat whisker device to touch the flat surface of the blade. Search for a sensitive spot with the whisker. I find that blue coated razor blades work very well. Some suggest heating the blade in a gas jet (electric stove will do) until it begins to glow, then cool it for use. One reader suggested a rusty blade is best. My advice is to get the radio going on a standard crystal, then switch over trying everything mentioned. Note: the corroded or treated surface of the blade acts as a rectifier. Do not allow the cat whisker to press down too hard on it thereby destroying the surface and shorting out the tuned circuit.

Off the Ham Bands

There are several remote controlled burglar alarm systems, but the range for my purposes is too short. Is there a system made to operate on the ham bands?

—J.F., Hazelton, PA

Ham bands are for exclusive hobby use! Everyone is trying to erode frequencies away from the hams for special interest purposes. All hobbyists should band together to assist the hams in their quest to preserve those precious few frequencies they presently have.

Needed No Crossover

My cousin added a piezoelectric tweeter horn electrostatic speaker to each of his speaker systems without any crossover whatsoever! It does sound great, but it shouldn't. Or should it?

—J.N., Dover, Del.

Most added-on piezoelectric horn speakers show a very high impedance to low frequency sounds so that virtually no power is pulled from the amplifier. As the frequency goes up, the impedance

drops and the efficiency of the speaker increases. In effect, "piezos" act as their own crossover. Try adding some capacitance in series with the horn to raise the horn's natural crossover frequency. You may find that it sounds a bit better, otherwise, forget the capacitor.

Where's Ameco?

I looked all over, but I could not find products from Ameco. I remember their old code course on records which was fantastic! What happened to Ameco?

—L.J., Salinas, CA

Ameco, I'm happy to say, is still with us. Write to them at 275 Hillside Avenue, Williston Park, NY 11596, asking for their catalog of products and a dealer's name near your home.

Registered Telephones

What are the legal details concerning privately owned telephones connected to telephone company lines?

—A.Z., Warwick, RI

There's no longer a requirement to use telephones and other equipment furnished by the telephone company. Under FCC rules, all new telephone equipment connected to telephone lines after July 1, 1979 must be registered or connected through a registered protective circuit. The FCC does not require registration of adapters or extension cords. So, look for the FCC registration on telephone products before you buy.

Used Car Radio Used

I can obtain used car radios almost at no cost—I have to take them out of junk cars myself. I have access to foreign and American types. What brand should I use for converting to household use? I have the 13.8-VDC power source and I can tap into my SW long wire for AM signals. Please answer.

—L.N., Upland, CA

A used radio is a used radio. They're all alike to me. So I suggest you select a handsome model from a Mercedes car. Be sure to get two or more units so you'll have spare parts. Mount the radio into the top of a bookshelf speaker. This way you have a nice cabinet and good sound.

Think Big

The switch for my car's rear window defroster keeps wearing out. How come?

—R.A., Fayette, MS

You're controlling a lot of juice. Each time you make and break the circuit, an arc eats away at the switch's contact points. Most switches are usually rated at 3A, and auto switches at 5A, which is too

INPUT/OUTPUT

little. Look for a 10-ampere switch, preferably a double-pole, double-throw type, and parallel the switch contacts into the circuit. Now, with a 20-ampere rating, the switch should last.

Mr. Clean Head

Hank, how often should I clean my cassette tape heads?

—E. R., Juneau, AK

A dirty tape head wears quicker than a clean one. I use a cassette head cleaner that makes a 10-second pass. The maker suggests cleaning after 10 hours of equipment use. I prefer 3-4 hours. Periodically I use a liquid cleaner on the heads, guides, rollers, etc. I blow dust out with a freon blower used by photographers. How long is periodically? Well, I clean the heads before each recording session or once a month, whichever comes first. To keep the heads clean, keep tape stored in the plastic boxes in which they are bought. Keep the tape door closed at all times, and dust the room and area near the cassette deck often.

Noisy Antenna

I suspect my CB antenna is defective but can't prove it. While moving on poor roads at 55 mph, I get erratic static which disappears at low speeds, on smooth roads, or when parked. How can I locate the trouble?

—J. N., St. Louis, MO

Disconnect the antenna cable at the CB set and connect an ohmmeter to its coax center lead there, and also at the top of the antenna. This is impossible to do with fiberglass sticks. The ohmmeter should read about 3 to 5 ohms. Now shake the antenna, gently tap the antenna mount with a rubber mallet, jump on the bumper, and, if necessary, road test the car across railroad tracks. If you have a faulty connection, the meter will swing to the high resistance reading on impacts. Don't drive the car and watch the meter at the same time. Usually, the antenna loading coil goes bad. Sometimes, it's the solder connections in the coax lead-in. Inspect everything you can to pinpoint and eliminate the trouble. For fiberglass antennas, use the SWR meter to detect erratic SWR, while travelling.

It Can't (Shouldn't) Happen!

Here in Minneapolis we have a 10-watt community radio station which is KFAI at 90.3 MHz on the FM band. I am using a standard indoor dipole antenna and would like to pull in more signal. I tried an outdoor antenna but this makes matters worse, due to overloading by powerful stations. What type of filter, booster, etc., can I use?

—K. L., Minneapolis, MN

The FCC assigns frequencies so that nearby FM stations will not interfere with one another. I suspect your receiver is not

of good quality. If you can't use a better FM receiver, connect an FM directional antenna and point it at the station you want or, if its location is unknown, rotate the antenna to the strongest signal. You may eliminate interference from stations behind and to the side of the antenna's main reception lobe.

Holds Tight

What is capture effect? A local car-audio salesman used the term, and when I asked him to explain, he said, "You know." Hank, I don't!

—K. M., North Canton, OH

An FM receiver can minimize the effect of a weak station operating on or near the frequency of a strong station. This is called capture effect! The capture effect causes the receiver to lock on the stronger signal by suppressing the weaker, but can fluctuate back and forth. When the two are of nearly equal strength, the receiver alternates abruptly back and forth between them. This rare instance usually happens in a travelling car as it passes from one city to another.

LED Drive Update

A while back I generalized by saying that LED devices available to hobbyists draw 20 mA under normal operating conditions. Well, close is not good enough. The table below lists various TTL and CMOS logic circuits and their maximum designed drive capability for interfacing with LED lamps.

Product	Description	Drive Current
74 Series	TTL gates	16 mA
74H Series	TTL high-speed gates	20 mA
74S Series	TTL Schottky gates	20 mA
74LS Series	TTL low-power Schottky gates	8 mA
74L Series	TTL low-power gates	3.6 mA
4049,4009	CMOS inverting buffer	3 mA
4050,4010	CMOS non-inverting buffer	3 mA
74C906	CMOS inverting buffer	8 mA
74C901/02	CMOS buffer	3.4 mA

Whata Skip

I turned on my receiver to an FM station (WQUE-FM New Orleans). On this particular day, the station was not coming in (I live 100 miles away from it) so I twiddled the dial a bit and encountered a very strong signal from another station. I listened to this station and did not think anything strange until the news broadcast. The weather report said that the temperature was -23°, and I knew I had stumbled onto quite a find. The station identified itself as WQFM in Milwaukee. Needless to say, I was quite amazed. The station faded out about ten minutes later. My question is, how did I receive this station?

—S. W., Hattiesburg, MS

Blame it on skip of an unusual type. The upper atmosphere was disturbed and ionized, causing this unusual skip. The cause of the disturbance could have been a meteor shower, solar storm particles, or maybe a natural phenomenon which we don't know about. That the skip *does* happen is attested to by your signal report and reports from reliable listeners hearing other events. Unfortunately, these events do not recur, nor are they predictable.

Lend a Hand

If you can assist, please do! Your help will promote electronics experimenting with a hobbyist, who in turn will make the hobby even more rewarding to you.

Δ Precision Tube and High Sensitivity Set Tester, Series 654; requiring copy of operator's manual; Lyle Mahlberg, 11605 West Highway 23, Duluth, MN 55808.

Δ Old table radios; need three radios to assist some youngsters in their new hobby—write first before shipping; Hank Scott, ELEMENTARY ELECTRONICS, 380 Lexington Ave., New York, NY 10017.

Δ New London Instrument Co. Amplifier, Model 160; needs all available information; Allan Nontoicik, 17301 Mapleton Rd., Maple Heights, OH 44137.

Δ Fast Tube Tester, Model FC-2; need all accessory parts; Arlen Johnson, RR 5, Box 137, Bluffton, IN 46714.

Δ Globe Electronics Scout Deluxe AM/CW Transmitter; need schematic and/or operating manual; Michael Nadeau, 28 King St., Waterville, ME 04901.

Δ Hallicrafters Model S-41G receiver; needs dials and schematic diagram; Tyson Tuttle, 5154 So. Manion, Tulsa OK 74135.

Δ Regency Range Gain 23-channel tube-type CB transceiver; needs general service data, schematic diagram, and owner's manual; Lori Miller, Box 2608, West Helena, Ark. 72390.

Δ Elmac PMR7 Amateur Receiver; needs manual and schematic diagram; Marvin Rosen, 20 W. Madison St., Baltimore, MD. (Editor's Note: Marvin assisted a fellow reader not too long ago).

Δ Cinima Television, Ltd. Electrical Stethoscope, Model 4C; need info from anyone who knows what it is—was purchased as surplus; John Kiss, Katslosa 13, 27012 Rydogard, Sweden.

Δ Waterman Type Pocketscope, Model S-10-A; requires schematic diagram and/or operator's manual; Robert T. Ulschmid, 69-34 66th Place, Glendale, NJ 11227.

Δ Telequipment Model S54A oscilloscope, made in England; any and all information greatly appreciated; Page P. Corner, WB7VEX, 390 S. Sutro Terrace, Carson City, NV 89701.

Δ Zenith Trans-Oceanic portable short-wave receiver, Model T600; owner's manual wanted; Adam Kaletski, 59 Lorelei Rd., West Orange, NJ (no zip given).

Δ Hallicrafters S-20R "Sky Champion" receiver; needs schematic diagram and troubleshooting information; Ernie Hoffman, 2613 Janet St., Kissimmee, FL 32741. ■

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This incredibly compact 4-channel/2-band crystal scanner plugs into the tape player where an 8 track cartridge normally goes.

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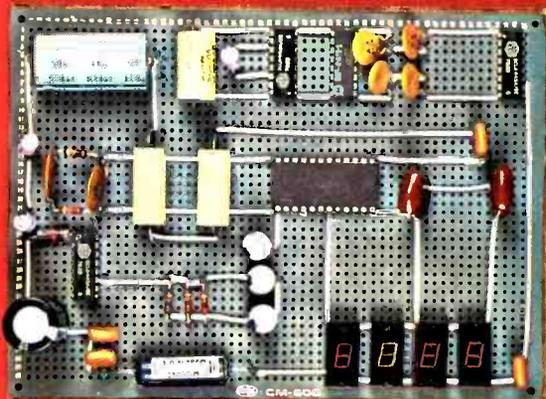
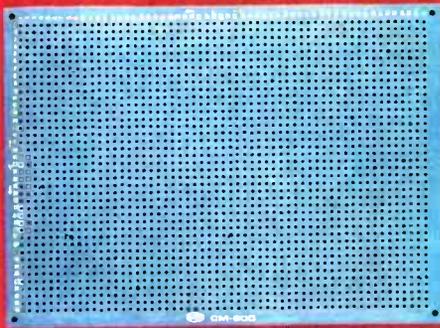


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