ELECTRONICS HOBBYIST

SPRING-SUMMER 1976 $1.35 02396

By the Editors of ELEMENTARY ELECTRONICS

FUN PROJECTS THAT EVERYONE CAN BUILD

CB POWER—
Operate your CB mobile rig indoors with goof-proof regulated power supply plus other CB articles of interest.

RADIO PROJECTS—
Listen to the exciting world of shortwave, AM radio, and even long-wave with receivers and gadgets made from our plans.

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Printing color or B&W snaps comes snappier with our tried-and-true darkroom projects.

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Keep your car in top mechanical shape and enjoy good sound while assembling simple low-cost electronic devices.

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Unusual projects for fun or science fairs that let you measure the wind, listen to snails, and build antique radio replicas.

PLUS—
Complete parts lists, instructions, diagrams, application tips, etc!

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ELECTRONICS HOBBYIST

SPRING—SUMMER 1976

New Products

Micro Cassette Recorder

Olympus Optical, a leading manufacturer of cameras and scientific instruments, has introduced the Pearlcorder-S micro—cassette tape recorder. The Pearlcorder-S is a pocket-sized, capstan-driven cassette tape recorder. It weighs less than twelve ounces. The wafer thin cassette will record or playback a full sixty minutes. The Pearlcorder-S and other micro-sized cassette recorders will eventually become as indispensable as pocket calculators. It can be used in a car, an office, an airplane, at home—virtually anywhere. It records lectures,

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meetings, notes in a classroom or sales meeting, and provides a means for audible reportage—all with a high degree of fidelity. In short, the applications for the Pearlcorder-S are limited only by the user's imagination. The convenient design of this all-metal unit permits one-hand operation of all controls. It sells for $179.95 with two batteries, earphone, plug adapter, and one cassette. Kits including additional attachments are also available at $199.95 for the "Standard" kit and at $239.95 for the "Deluxe" kit. The Pearlcorder-S is being introduced in key city retail outlets, with a broad scale advertising and promotion program. For more information, write to Olympus Corp. of America, 2 Nevada Drive, New Hyde Park, NY 11040.

Electronic Organ Kit

Remember the big sound of those melodic pipe organs in movie palaces all over America? The same authentic sound is faithfully recreated by the "Theatre" electronic organ, one of five models which can be built from a kit engineered and produced by The Schober Organ Corporation. The kit is complete down to the last piece of wire. Detailed, step-by-step instructions, with easy-to-follow drawings and diagrams, are included. Personal assistance from the company's technicians is available by mail and phone if necessary. Building a complex musical instrument with a kit is not an overnight project. People accustomed to working with basic tools can assemble a "Theatre" organ in about 150 hours. Those whose experience is limited will more likely take about 200 hours. The average price of a basic Schober "Theatre" organ kit is about $2,500. A wide range of optional equipment is also available. Designed by musician-engineers, the Schober organ is considered by many people to be the "ultimate" do-

it-yourself kit project. Unlike pianos, an organ keyboard, known as a manual, consists of 61 keys. The "Theatre" organ has two manuals, the upper one is known as the "solo" manual, and it is this one that usually carries the melody. The lower manual is known as the "accompaniment". The organ has 35 voices. The range of voices can be augmented by special Schober accessories. The Percussion Group adds sounds of eight different percussion instruments. Schober cosiders its Dynamaster the "fun and games" addition to the organ; it's a sophisticated, automatic rhythm device which backs up the melody with a Bossa Nova, Beguine, Tango, Cha-Cha, Waltz, March or Jazz accompaniment—just to name a few. The "Theatre" organ kit is one of several models produced by Schober. The organs may only be obtained directly from the manufacturer—they cannot be purchased in retail stores. For a copy of the booklet, "Before You Buy An Electronic Organ," a full color catalog, and a 12-inch LP record demonstrating all five Schober organ models, write The Schober Organ Corporation, Dept. EE1, 43 West 61st Street, New York, NY 10023. Please enclose $1 for handling and mailing.

Solderless Breadboard Kit

Continental Specialties Corporation's new Proto-Board 6 may well be the lowest priced solderless breadboard kit on the market today. This compact kit can

3 ways to get more mileage out of your CB radio

(and stay out of trouble with the FCC)


Keep your transmissions static-free and within the law.


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CB RADIO CONSTRUCTION PROJECTS—Build meters, oscillators, adapters, monitors—and save a small fortune. Parts lists are featured for 18 projects to help you extend your range to the legal limits, reduce interference, and more. **$3.95**

99 WAYS TO IMPROVE YOUR CB RADIO—Stop generator whine, regulator rasp, and other sources of noise and interference. Discover how to clean, troubleshoot, repair, and align equipment. This recently updated edition shows you what to buy and what to build. **$3.95**

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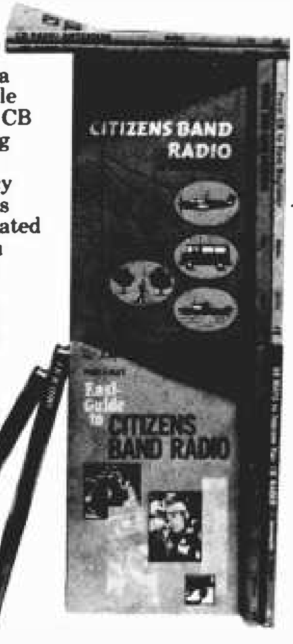

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121(R1)

GET INVOLVED

CITIZENS BAND RADIO HANDBOOK—This manual is for everyone who is seriously involved in CB radio. Useful information on licensing and equipment, servicing hints, a glossary, and a 25-page section on FCC rules are included. **$5.50**

FROM CB TO HAM BEGINNER—Broaden your involvement with 2-way radio. Have fun—talk to other continents as a ham. This book offers the technical know-how you need to put your station on the air. **$4.75**

Easi-Guide to CB RADIO FOR TRUCKERS—Now—in plain English—read how CB rigs can make the trucker's life more convenient. It's like having an "expert" in your cab—feeding you tips on equipment, licensing, rules, and more. **$3.50**

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Easi-Guide to CITIZENS BAND RADIO—Learn or brush up on the basics of CB radio the easy way—through conversational text and 170 photographs. This fun-to-read guide is packed with CB information you can really use. **$3.50**

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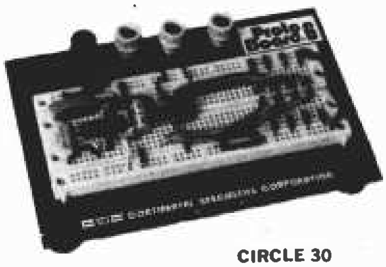
EA 13B

New Products

be assembled in minutes and offers six 14-pin DIP IC capacity for basic breadboarding, testing, and building applications. Selling for only $15.95, the American-made PB-6 includes one QT-47S solderless breadboarding socket, two QT-

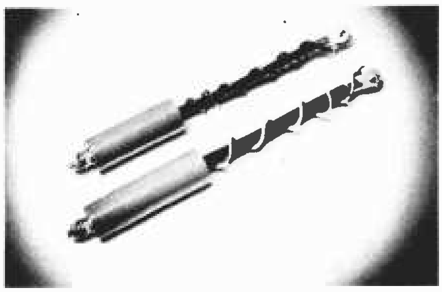


CIRCLE 30 ON READER SERVICE COUPON

47B bus strips, four 5-way binding posts, a metal ground and base plate, rubber feet to prevent scratching work surfaces, all nuts, bolts and screws, plus complete easy-assembly instructions. The PB-6 lets the user test and build circuits without soldering or patch cords; all interconnections between components are made with common #22 AWG hook-up wire. This quality breadboarding kit includes 630 component tie points at less than 2.5¢ each. The Proto-Board 6 is available from local distributors or directly from Continental Specialties Corporation, 44 Kendall Street, P.O. Box 1942, New Haven, CT 06509 or 351 California Street, Box 7809, San Francisco, CA 94104.

Noise Filters for Mobile CB

Cornell Dubilier has developed a 60 amp and 100 amp Alternator/Generator Noise (Electromagnetic) Filter. These units, designed for easy installation, black out unwanted "conducted" noise created by alternator/generator systems in automobiles, trucks, tractors, other farm equipment, and marine vehicles.



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The filters are designed with capacitive and inductive elements, thus providing a broad range of noise suppression. They do not require tuning, further simplifying their use and applications. The CB60 and CB100 are designed for long trouble-free life and can withstand shock, vibration, corrosion, and temperature extremes. They are installed by simply removing one bolt from the alternator/generator and installing the filter's termination. Flexible cabling allows easy application in a variety of vehicle configurations. They are packaged with clearly defined and easy-to-understand instructions, and are available from local dealers. The CB60 and CB100 are priced at $8.75 and $12.95 respectively. For more information, write to Cornell Dubilier, 150 Avenue L, Newark, NJ 07101

200 Years Later

In commemoration of our country's 200th birthday, Radio Shack is offering an exclusive, limited edition Realistic Bicentennial AM Radio. This unique collector's item features an accurate reproduction, custom crafted in cast metal, of the famous *Spirit of '76* Fife 'n Drum Trio, mounted on a plastic base with

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simulated walnut grain finish and cannon ball feet. The base is accented with an embossed Bicentennial plaque. The original painting, *Spirit of '76*, was done by Archibald M. Willard in 1876 and was displayed at the Philadelphia Centennial Exposition. Since 1880, the picture has been on display in Abbot Hall in Marblehead, MA. The Realistic Bicentennial AM Radio is 7½ x 4⅛ x 4⅛-in. and comes with 9-volt battery in a red, white and blue gift box. Priced at $19.95. Available exclusively from Radio Shack stores and authorized sales centers, nationwide.

CB Monitoring Plus All the Rest

Citizen band monitoring is now a part of the popular Panasonic Tech Series' multiband radio line with the introduction of the new Tech 1000. With a combination of rugged good looks and rich sound, the new portable radio offers six bands heard through a 6½ inch double range speaker. Along with CB monitoring from 26.8 to 28.4 MHz, (which covers all 23 channels), the Tech 1000 offers full coverage on Short Wave (1.6 MHz-30 MHz). Bands include CB, SW1, SW2, MB, AM, and FM. The radio features fine

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Name (print clearly) ________________

Address ________________

City ________ State ________ Zip Code ________

New Products

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tuning especially for precise Shortwave reception and two antennas—a gyro antenna for AM/MB and a whip antenna for the remaining bands. Among the other features are an AFC/DX Local switch, a BFO switch for SSB and CW, a 120-minute on/off timer, separate bass and treble controls, a tape dial, and dial light button. With earphone compartment pocket and a detachable shoulder strap, the Tech 1000 has a suggested retail price of $129.95. Available at appliance outlets throughout the United States and Canada.

Headphone Adapter

A special adapter is now available from Switchcraft, Inc., Chicago, for use in connecting stereo headphones to monaural program sources such as cassette recorders/players, radios, TV, etc. The listener simply plugs in his stereo headphone to the extension jack on one end of the Model 396P1 adapter. He plugs in the other end of the adapter to the phone jack or mono source. The plug end has a molded-on Switchcraft

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"Tini-Plug" miniature commercial phone plug. Both the plug and the extension jack at the other end of the 6 inch cable are fully shielded and have built-in strain relief. The jack accommodates a 3-conductor commercial phone plug. 2-conductor plugs should never be plugged into the extension jack; equipment could be damaged by shorting of the ring spring to the sleeve of the 2-conductor plug. Price is $4.15. The item is stock available at electronic parts dealers everywhere. Request New Product Bulletin No. 291, Sales Dept., Switchcraft, Inc., 5555 No. Elston Ave., Chicago, IL 60630.

Electronic Stopwatch

Edmund's pocket sized 4-oz. electronic digital stopwatch has features that make wind-up stopwatches obsolete. Accurate to ± 2% of the last digit, in increments of 1/100 of a second, it has two timing methods—mechanical pushbutton On/Off and electrical remote On/Off—making it ideal for time and motion studies, and use in lab work. It starts, stops and re-starts (accumulates time). A 6-digit LED display gives instant error-free readouts up to 9999.99 seconds (over 2¾-hours). Durable enough for field use, its remote jack and cord allow triggering with any device supplying between 3.5 and 15 volts AC or DC. Use it in re-

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search experiments involving critical timing. Its accuracy is useful to the graphic arts industry, and other industries requiring multiple timing phases; its low price makes it feasible to place several units at various work stations. Use it also to keep phone bills down by timing long distance calls. This digital stopwatch fits in your hand and operates easily. The start/stop button is tripped by your index finger; the reset button is worked by your thumb. A 9V rectangular transistor type radio battery to power the watch is included. The unit (Stock No. 1943 . . . $69.95 postpaid) is available by mail from Edmund Scientific Co., 380 Edscorp Bldg., Barrington, NJ 08007.

R/C Bridge

Continental Specialties' new Design Mate 3 is a low cost R/C Bridge which takes the guesswork out of deciphering color codes and unreadable markings. It measures component values to better than 5% in seconds using only two operating controls and a unique solid-state null detector. Completely wired, tested and calibrated, together with instructions, operations manual and theory, the Design Mate 3 sells for only $54.95. Manufacturer's specifications: Resistance Range: 10 ohms to 10 megohms in six

(Continued on page 101)

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CIRCLE 1 ON READER SERVICE COUPON

Got a question or a problem with a project—ask Hank! Please remember that Hank's column is limited to answering specific electronic project questions that you send to him. Personal replies cannot be made. Sorry, he isn't offering a circuit design service. Write to:

Hank Scott, Workshop Editor
ELECTRONICS HOBBYIST
229 Park Avenue South
New York, NY 10003

In Time

Where can I obtain a schematic and a parts list for an electronic digital stopwatch?

—J. W., New Salisbury, IN

The Editor tells me just such a project is in the works and it has calculator options. Watch for it in ELEMENTARY ELECTRONICS.

SWL Kickoff

I am 15 years old and I want to purchase a Heathkit SW-717 4-band shortwave receiver. Is this a good receiver for a beginner like me?

—D. W., Somerville, NJ

Any receiver is a good receiver to start with. I began with a one-tube triode I built from magazine plans.

He Wants to Be President

Is there any national organization specifically for electronics hobbyists and experiments? How feasible do you think it would be for a high school student to start one?

—S. G., Great Neck, NY

None to my knowledge except for those who read this magazine. Why go national? Start a club in your high school.

He's on My Back

Hank, you goofed in the September/October 1975 ELEMENTARY ELECTRONICS when you answered E.E. of Ellenville on "Wind Power." Most any IDJITT knows that a car's alternator done got two big diodes and what comes out is D.C. I got me one of them set ups, I run my 12V 25W TV 24 hours all day, and I can go almost a week without no wind 'cause I got me four 90 A/H car batteries hooked up. So thar!

—D. H. S., Las Vegas, NV

I published your letter as you wrote it 'cause I knew you slaughtered the Queen's grammar on purpose for effect. Now to the point—your application is correct and a darn good one, too! However, outside of driving a TV set, you're making no other use of the available power. Also, the diodes rectify the alternator's output which is now pulsating D.C. which you use to charge the car batteries. If you want to use the alternator output for heating purposes, bypass the diodes. They have a contact potential which limits power transfer and internal resistance which is wasteful also. You see, I wasn't all wrong. By the way, do you watch TV 24 hours a day, every day?

Solid Ground

How come today's SW receivers do not require a ground connection for the antenna like in the old days?

—F. N., Simcoe, Ont.

They still do for best results. However, today's receivers sneak to ground through the 117 VAC power line. A good RF ground for the antenna is a must for serious DXing.

Watt Gives?

How many watts equal one joule?

—R. R., Chatsworth, CA

You're trying to trick me! One joule is equal to one watt-second. Energy is equal to power times time. You must be studying high school physics.

Solid Gold

I know how a gold leaf electroscope works, but why gold leaf?

—D. B., Norman, OK

In an electroscope the gold leaves rest hanging down against each other. When a static charge covers the leaves, this charge is alike on both leaves and the leaves are repelled. If the leaves were heavy, it would take a large charge to displace the leaves, whereas the function of the electroscope is to detect very small charges. Gold is a heavy metal but it can be pounded into very thin leaves that would float on a whisper of air. That is why gold leaves are used and are contained inside a glass jar where air motion cannot disturb the leaves.

Fusing With Copper

Hank, I know that #12 AWG copper wire will carry 20 amperes of current safely, but what I want to know is how much current will melt the copper?

—J. M., Jackson, OH

Believe it or not, there is an equation to find the current at which the fusing (melting) point of wire will occur. It is $I = Kd^{3/2}$ where d is the wire diameter and K is a constant that depends on the metal used in the wire. For #12 copper wire, K = 10,244 and d = 0.0808. Figure it out on your calculator—the answer is 235 amperes. Why do we fuse #12 at 20 amperes maximum? To avoid the unnecessary heat build-up and voltage drop along the conductor. By the way, the K for aluminum is 7585 and #12 AWG aluminum wire can take up to 174 amperes before fusing. That's less than copper, so that is why larger diameter (low number) aluminum wire is used to replace copper wire.

IC Unlisted

The ICs you use in projects do not match those in my Motorola book. Why?

—J. B., Toledo, OH

Motorola is only interested in selling Motorola ICs. So don't look for a National, RCA, Fairchild, etc. chip unless Motorola makes the exact replacement.

Line Cord vs. Antenna

The wavelength of a 60 Hz wave equals 5 million meters, so in one direction half the wave travels 2.5 million meters. Connect a lamp with a short piece of wire to a 60 Hz generator and you've got 60 Hz current without 2.5 million meters of wire. Explanation?

—S. J., Victoria, B.C.

What's to explain? You said it and it's true. Of course, if you wanted to resonate a 60 Hz line, you would need 2,500,000 meters of wire. But why do that when all you want to do is turn on a lamp.

Can You Help?

You never know how a minor effort on your part will be an enormous help to one of our readers. Please help if you can.

△ Wanted: members for a Police-Fire Monitoring Club—write to Scott Freeman, 1-26A Pine St., Pinehurst Dr., Lakewood, NJ 08701.

△ G. R. Goydic, 4810 Daisy St., #C, Oakland, CA 94619 can use the operation instructions to the Simpson 260 multimeter.

△ If you have a B&K Cathode Rejuvenator and Tester, send a Xerox copy to Lester W. Kroepel, 803 No. Morrison St., Appleton, WI 54911.

△ Would some old timer have the schematic diagram for the Arkay VT-10 multimeter? If so, please send a copy to Keith Gename, 5150 So. Oak Park, Chicago, IL 60638.

△ John S. Meko would like a service manual and/or schematic diagram for the Bell 360 Stereotape Recorder, Model RT-360. Send it to 423 W. Magnolia #1, San Antonio, TX 78212.

△ If you have the schematic diagram for the Midland 13-865 CB transceiver (1968 vintage), send a copy to Robert Falcone, 161 Ridgewood Ave., Absecon, NJ 08201.

△ William T. Veness is restoring a Zenith all-wave radio, model 1005 (Serial No. S-704653) and needs to replace the tuning drive belt. Any help or advice will be greatly appreciated. Bill is located at P.O. Box 692, Bradenton, FL 33506.

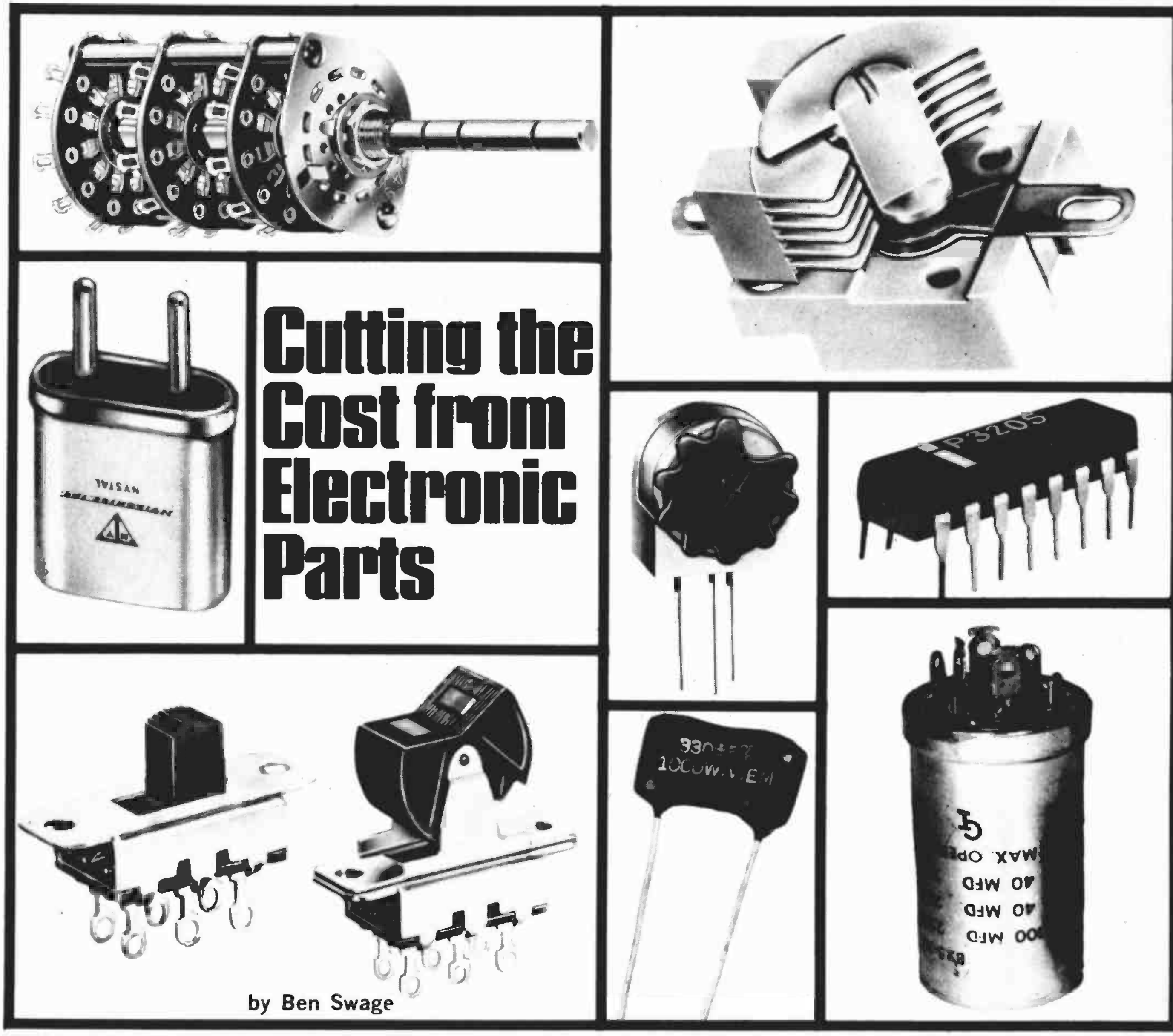
△ Steve Minkin needs the schematic diagram for the Crosley 52-SD. Write to 1525 N. Coleman Rd., Knoxville, TN 37919.

△ If you have any info on an old Navy receiver (name tag states N17-T-73701-5366, UTC G-5551A, RCA 8889252-1, TF 1A 0344) send it to Ray Rodriguez, 8412 Georgian Dr., Austin, TX 78753. He has to replace a transformer.

△ L. Feher of 71 West Ave., Hicksville, NY 11801 needs info on his National 173 receiver. Help out, please! ■

ELECTRONICS HOBBYIST
SPRING-SUMMER 1976

Cutting the Cost from Electronic Parts



by Ben Swage

The guy behind the parts counter will rip you off if you don't buy wisely!

IS IT WORTHWHILE spending $50 to $100 to build a project your next-door neighbor can build for $10? No! Then consider this: We have a sister publication called 101 ELECTRONIC PROJECTS FOR UNDER $15. We know every project in that publication can really be built for less than $15 using readily available components, yet we have received letters from readers insisting they built certain projects "using the exact components called for" for total costs running between $50 and $100. Obviously, something is wrong with the way many hobbyists shop for parts.

If you regularly build projects there's no reason why you can't bring it in for as little as 20% of the *list price* of the components at your local parts distributor—and bear in mind that in today's marketplace the so-called "amateur net," or "user net" price is really *full list*. Just to show you what you're up against when it comes to buying parts let's digress for a moment and talk of a very popular blister-packaged semiconductor line. Originally, the blister cards had two prices: Printed on the card would be a list price, say $1.59. Then there was a small tab with "user net price" of 95¢, a difference of 64 cents, or almost 33% of the *true* user price. Supposedly, the buyer was getting a discount from the list price. But many, many distributors got cute and wanted to squeeze every penny out of the sale, so they removed the net price tab, and the buyer pays the full list price—a price originally intended to be imaginary; no one believed anyone would pay the list price.

(Continued on next page)

CUTTING COSTS

Let's digress one more time so you get the full flavor of what you're up against; and then we'll show you how to save *big* dollars on every project. A UL-approved U-ground plug (the standard three wire electrical 110-volt plug used for household and consumer equipments) sells for well under a dollar in *full list price* hardware stores; generally the price is 89 cents. Private-label packed for a discount store the plug might run from 69 cents to 99 cents. This very same plug, blister packaged under a nationally known electronic brand name, sells in "electronic part stores" for $1.69.

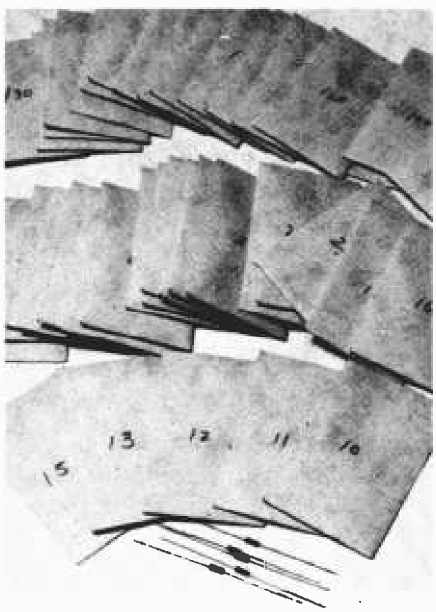
You can get big savings by simply keeping in mind you're not building projects for the military, nor a NASA shot at Mars. Unless a component used in a project is directly specified as "do not substitute," as a general rule just about any experimenter grade component will work well. For example, you can pay as high as $1 (or more) for a low-noise metalized resistor, yet most projects work just as well with a run-of-the-mill 3-cent carbon ½ watt resistor. Similarly, you can pay two or three dollars for a tantalum capacitor to be used in a circuit that works perfectly well with a 29-cent electrolytic. Even when you need precision value components there's a way to get them for pennies on the dollar.

Start Looking. The first place you can save money is with a well stocked "junk box," for anything you have in stock is a 100% savings. Any project or experimental device you no longer use or need should be dismantled for the usable parts. Now, we don't mean a complete salvage job for nothing is as dull, or as likely to turn you off, as trying to salvage resistors and capacitors with half-inch leads; there is simply no logic to spending an entire evening trying to salvage a few dollars worth of resistors that will probably wind up never being used because of short leads. Go instead for the big, expensive hardware.

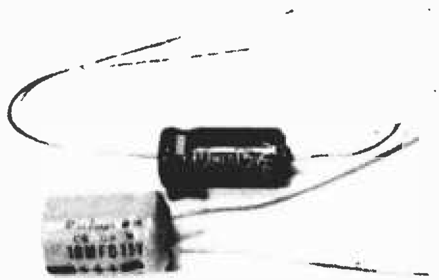
For example, filament type power transformers (perfect for solid state projects) can set you back from almost $2 to well over $5. Any filament or power transformer—even with extra short-leads—is worth saving. And don't overlook switches: Last year's $1 subminiature toggle switch goes for at least $1.75 this year; in some places as high as $2.25. A potentiometer? That's worth at least a buck, or more if it has a switch. A tuning capacitor? You're talking big money; that subminiature you used to use in shortwave boosters that cost 49¢ now goes for $1.39 and up, while that "surplus" tuning capacitor you bought for under 50¢ will set you back almost $2.50 if you buy it for a new project. Phono jacks used to be under 10¢; the same jacks, now in a fancy blister package, are about 25¢ each; yet phono and phone jacks are easy to salvage.

Get the idea? Don't bog down salvaging the nickle and dime stuff; you'll get tired and quit. Go right for the big, expensive items and squirrel them away for the next project. And don't forget the cabinet itself, particularly since a $1.49 minibox sells for up to $5 in some stores. Save the good half. For example, suppose you've made a project in the main section of a 3 x 4 x 5-inch cabinet. Save the cover, as it has no holes. The next 3 x 4 x 5-inch project you salvage might have been assembled on the cover, and you can salvage the base. Now you have one base and one cover: a complete cabinet. Again, *big* money saved rather than nickles and dimes.

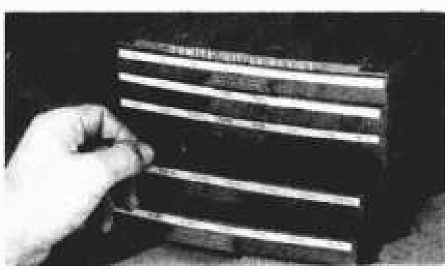
The Small Stuff. Naturally, you will never have enough parts in the junk box to cover everything. The first place you're likely to run short is in resistors



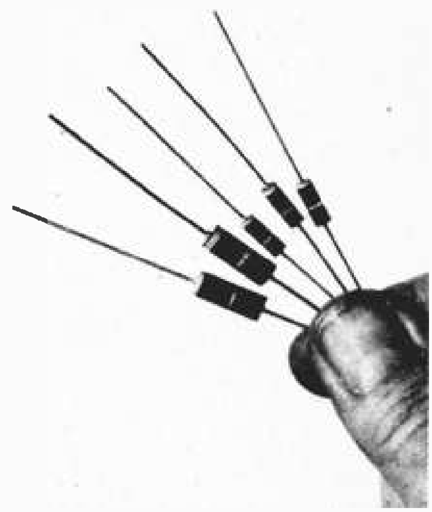
Real savings and convenience come in a resistor "proto-kit." Averaging out to less than 4¢ apiece, this ¼-watt, 5%-tolerance kit has ten resistors of every standard 5% value from 10 ohms to 1 megohm. Part of the cost goes into the packaging that separates each value in a small envelope that fits a standard kitchen drawer cutlery tray—making for convenient storage and value selection. Smaller kits are also available in standard 10%-tolerance values at proportional reduction in cost.



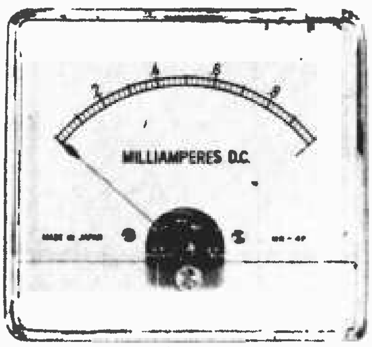
An example of surplus buying. Top axial lead capacitor costs 49¢ in a blister pack. Lower capacitor of same value with single-ended leads (printed circuit) was purchased from a surplus dealer for 5¢. Isn't it worth 42¢ just to re-arrange a couple of circuit leads?



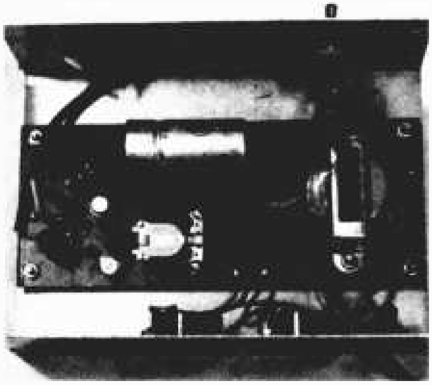
What do you do with salvaged and excess resistors? File them! Here, the author files resistors in a four-shelf bin he's used for years. If you can't find one, look in 5-&10¢ stores for plastic bins used to file buttons and small parts. Surplus resistors are never used if you can find them quickly.



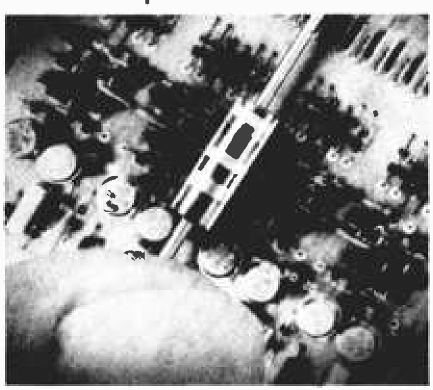
If you don't mind separating the resistors yourself the small "100 for $ . . ." resistor kits are the best buy, and you might wind up with precision lo-noise type resistors; but in general you get standard resistors. As an example of what you get and save, the resistor on top is 10,000 ohms, ½ watt, 10% and cost 15¢ at the local "parts distributor." The resistor on bottom looks the same, and it is, but it cost only 3¢ in a "100 for $3" kit. But make certain the kit has standard values in decent proportions. Too often, the "100 for . . ." kits have oddball values in quantity, like 30 pieces of 1 megohm, and 1 meg isn't too common in solid state projects.



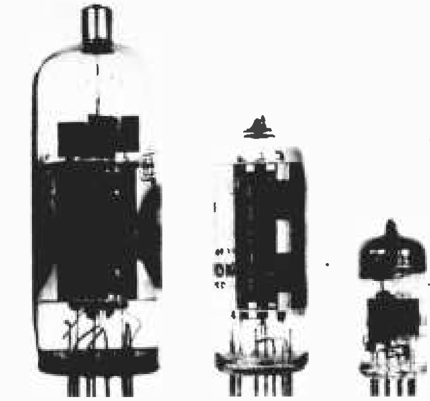
Considering the out-of-sight price of meters, never discard a meter. In fact, the meter shown in the photo was used in four projects and is currently being worked into a new project. Meters are hard to come by, so look to junk electronic items where meters are a part of the unit.



Those old projects are a gold mine. If you try to salvage every resistor and capacitor you'll probably get bored and scrap the whole bit. Go for the big, expensive hardware: AC sockets, transformer, relay, switch, and high-uF capacitor. The rest is scrapped. Just these six items alone represent $18.89 at current prices and going higher every day. Would you believe this entire project including cabinet cost under $10 just a few years ago—using "all new" components?



Where did I find thee? "Why on an old printed circuit board along with eight 2N1305 transistors, 14 signal diodes, 14 disc capacitors and a bunch of other resistors like me in size but of different values," said the color-coded 5%-tolerance resistor. This surplus bargain was picked up locally by the author for only one dollar.



Don't quit on vacuum tubes. There are many worthwhile projects you can build from old magazine articles (even some new ones) that use vacuum tubes. In many cases you can salvage vacuum tubes from old projects, radios, hi-fi equipment and television sets at no cost. Wipe them clean with a damp cloth. If you can't read the tube-type markings, breathe on the glass, it may bring up the lettering.

When salvaging old projects keep your eyes open for parts you can't get anymore, even if you can't think of a need for them now. A few years ago this capacitor was standard stock in just about any "radio parts store." If you needed one today you'd find it easier to locate the Holy Grail or a golden-egg-laying goose. And you'd pay what a golden egg is worth. This type of salvage is literally worth its weight in gold. Save it all.

and capacitors. A resistor sells in most stores for 15¢ each (½ watt, 10% variety). If your project calls for, say, 10 resistors, you've got a buck-and-a-half right in the pot and you haven't even started construction. But if you buy in *bulk* you knock the cost down to 3¢ or less per resistor.

Almost all the major distributors, such as Radio Shack and Lafayette, offer popular value assortments of 100 resistors for about $3. You generally get sufficient "standard" values to meet most needs, or you can parallel and/or series connect a few resistors for any desired value. But, face it, there will be times when you run out of values and will have to pay premium prices for one or two pieces. You can, however, if you're an active experimenter, get one of the Mouser Electronics proto-kits: 10 each of every 10% standard value from 1 ohm to 22 megohms (890 resistors) for $42.95, or you can buy in bulk at about 2½¢ per resistor in quantities of 100. For the active experimenter a single proto-kit is good for years of construction.

While we're on the subject of Mouser Electronics, they sell electrolytic capacitors in single quantities for about 30% of what they cost in the local stores. Only the "surplus" dealers can beat their prices. A Mouser catalog is a must have for any builder, though Mouser has a minimum order of $20 total. But their catalog is so packed with top quality components at rock-bottom prices that the active hobbyist or experimenter can easily meet the minimum figure.

Solid Talk. Before moving on to the subject of "surplus" dealers, where you can get outstanding quality components for next to nothing—or lose your shirt—let's talk about solid state devices such as transistors, diodes, popular ICs, SCRs, etc. This is the type of material which might be classed as *non-digital*—material for amplifiers, power supplies, control circuits, etc. While it is quite true that there are many tens of thousands of transistor and diode types, it is also true that for general hobbyist and experimenter applications several hundred types or even several thousand types can be substituted for by one single unit. The reason for this is that many solid state devices are upgraded as they come off the production line. For example, from one production run of transistors everything that comes out with a gain of 50 might be designated 2NXXX1, while others with a gain of 100 to 300 might be 2NXXX2 while still others with a gain of 300 to 500 might be 2NXXX3. This is how many transistor "types" were originally "developed." Then again, many solid state devices were originally designed for specific applications. For example, the 2N4888 is a general-purpose high voltage transistor sought after by radio amateurs for use in transmitter keyers because it is a *silicon* PNP rated for use in 150-volt circuits and sells for about 50¢. (Keep this figure of 50¢ in mind.) There is absolutely no reason why this transistor cannot be used in any circuit of less than 150 volts, and in fact many other transistor types are similar in performance with the exception of the voltage rating.

Now finding a 2N4888—should you need one—is second only to the search for the Holy Grail. It is almost impossible to locate any specific transistor type other than early experimenter types such as the 2N107 and 2N109 because there are just too many different devices for even the largest electronics dealer to stock. And this lack of stock applies equally to diodes, SCRs, ICs, etc.

But since performance specifications are so similar between devices, and because so many different types can be used in lower voltage circuits—for example, the popular 1N4005 rectifier diode replaces the 1N4001, 1N4002, 1N4003, and 1N4004, while the 1N4007 replaces all of these and a few more—it is possible to come up with a line of a hundred or so "general replacements" that will cover just about all popular, and some not-so-popular, solid state devices.

Buck Grabbers. Several large and a few smaller blister-packaged lines are available with so-called "general replacement devices," and in most instances you will find a general replacement for the specific transistor, diode, or SCR you might want. But you pay heavily for this convenience. For example, the 2N4888 transistor previously mentioned, which is available for about 50¢, will cost you between $3 and $4 as a general replacement. Yet in most hobbyist circuits and projects you could replace the 2N4888 with a 2N5400 or a 2N5401, both costing less than one dollar, a fraction of the general replacement cost.

Let's look at another example: Poly-Paks will sell you the popular 1N4004 rectifier diode for 7½¢ (10 for 75¢); a general replacement for the 1N4004 from a nationally distributed line will cost you at least 45¢ apiece. If you needed a bridge rectifier, the four Poly-Paks diodes would cost you a total of 30¢. If you used general replacement diodes the rectifier would cost you at least $1.80. Multiply this type of price differential by several times and you know why some hobbyists can build a project for less than $10 while the guy next door spends $25, $50, or even $100 for the same project.

Surplus. While it is true that you cannot run down to the average local electronic parts distributor and buy the exact solid state device called for, there are many, many "surplus" dealers specializing in just the type of devices you need. In most instances the "surplus" stock is first quality—generally an overrun, or excess purchase the dealer

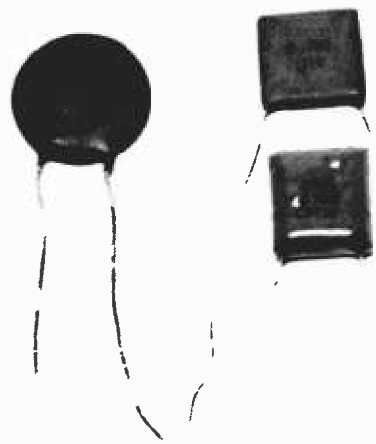
Thank heaven for surplus! The SPDT mini-switch at bottom came right off a peg-board rack for $1.75. The SPDT mini-switch on top has the same contact ratings and was purchased new through a mail order surplus house at 10 for $1, or 10¢ each. Maybe there would be a difference in performance on a NASA space shot, but not in a hobby project.

picked up at bulk rates. It makes no difference how he got the parts, he resells it to hobbyists at really rock-bottom prices. For example, you can get most "standard" 7400 series digital ICs from the surplus dealers for an average of 25¢ each. The same item from a blister-packaged job-rack might cost you over a dollar.

Then again, even if a surplus dealer doesn't have the exact part you need he will probably have a direct substitute—again at bargain prices. How do you know what to substitute? With the most important book in any hobbyist's library: the Howard W. Sams Transistor Substitution Guide. (There are many other guides but this is *the best.*) The guide tells you what transistors (and diodes) are direct substitutes, close substitutes, and even the closest "nationally distributed general replacements." Guides are also available (from other sources) for IC substitutions (try National Semiconductor, Motorola, and RCA). It is more than likely that at least one of the surplus dealers will have the exact devices needed or a direct substitute; but just as you can't tell the players without a scorecard you can't tell the substitute from the specified part without a guide.

Mentioning Names. There are several surplus dealers, all with excellent reputations, that specialize almost entirely, or to a large extent, in solid state

Never throw out a loudspeaker—they cost too much! Salvage from old radios and television sets, even old car radios and CB sets. True, they go bad with time and dampness, but if you have a supply, a few should be serviceable. Fix small punctures and tears in the paper cone with nail polish. Store with cardboard over the face of the cone to protect it from accidental damage.



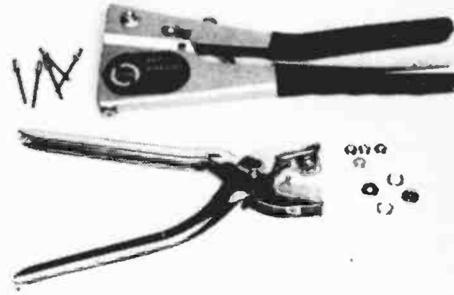
Using your head can save big money. A new 0.47 uF low voltage capacitor (left) costs 89¢. Two salvaged capacitors (right)—0.2 uF and 0.25 uF—connected in parallel equal 0.45 uF; close enough in value to 0.47 uF to substitute, and they cost you nothing. Or, the parallel capacitors might be new items you had in stock; remember, using what you have is also a savings.

devices at low prices. Among the best known are Circuit Specialists Co., ADVA, James, RGS, Ancrona, and the aforementioned Poly-Paks. Several surplus dealers, as well as others such as John Meshna, Babylon, RGS and Selectronics, also specialize in surplus of just about anything—such as capacitors, po-

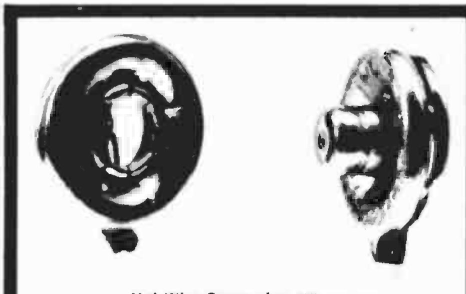
(Continued on page 100)

Eyelet-Popping Connectors

by Jorma Hyypia

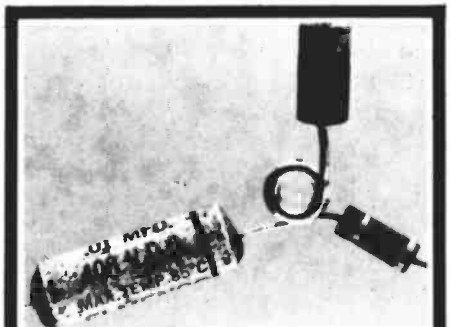


☐ Here are several handy ways to use a "pop" rivet tool and an eyelet tool to make solderless connections when building electronic gadgets and when repairing home appliances. Obtain several sizes of rivets and a stock of washers that will slip neatly over the rivet shanks. If a rivet is too long for a particular job, slide it off the long pin and file or hack saw to the desired length. Your eyelet fastening tool will be doubly useful if you obtain one that is also capable of setting snap fasteners. Although these are basically solderless joints, you can add solder to obtain better electrical connection between joined wires. However, remember that you cannot solder to the eyelets which are of aluminum, and that you should not use colored eyelets which would not conduct electricity. If in doubt, check conductivity with an ohmmeter. Always check that the appliance or gadget you have fixed or assembled is safe to operate. Check carefully for shock hazards. Be sure insulation is sufficient.



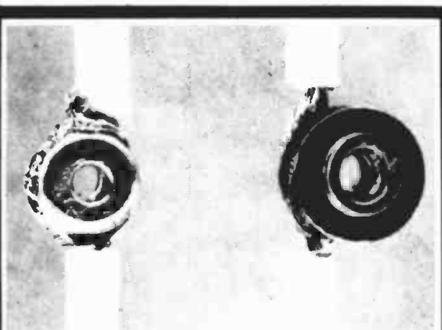
Hot-Wire Connector. Where you anticipate the need to disconnect joined wires, try this trick. Just attach the bared wire ends to the two halves of a clothing snap fastener using an eyelet setting tool having this capability. For example, place the socket portion and its mating prong ring into the tool jaws, run the bared wire strands (flatten the bundle) completely across the prong ring, and mate the socket and prong ring by squeezing the tool. Attach the other wire to the stud section in the same manner. A handy connector for breadboarding or wherever the connection needs to be taken apart frequently.

Take-Apart Connector . The burned-apart ends of a heating coil in a space heater or other appliance obviously cannot be soldered together. For an emergency repair, try this: form loops on the ends of the wires that just fit the shank of a "pop" rivet and place the loops between two washers slipped on the rivet. Set the rivet to make a really tight physical connection. To ensure good electrical contact, be sure to brighten the heater wire loops with sandpaper or light filing.



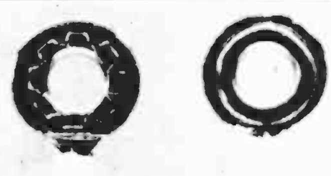
Components Joiner. Want to join several resistors, capacitors or other electronic components together in a jiffy? Just wrap each lead a full turn around the shank of an eyelet, and pinch the eyelet shut with the tool. This provides a good mechanical joining of the wires, but you can run in some solder if you like. The eyelet ring is handy for mounting the assembly on a bolt or other support.

Rivet-Eyelet Connector. Insert the bared wire ends into an eyelet from the flange side, then add a ⅛" x ⅛" "pop" rivet from the same side. Set the rivet with the rivet tool. The wire ends are thus pinched between the rivet and inside of the eyelet for a tight fit. Note that this connector provides a stand-off shank with a hole rhrough the middle that can be used to mount the wire joint a fraction of an inch off the assembly panel on which it is used.



Rivet Wire Connectors. To join two wires quickly without soldering, wrap the bared wire ends around the shank of a "pop" rivet, add a small washer, and set the rivet with the rivet tool. For a stronger connection, or when using heavier gauge wire, sandwich the wire ends between two washers that just fit the rivet shank. The handiest rivet size for most applications is ⅛" diameter with a ⅛" work thickness rating. This is a handy way to connect a line cord to iron wires found in older appliances. Note that the "pop" rivet has a hole in the center through which you can insert a screw, bolt or nail to mount the connector to a panel.

Wire Clamp and Strain Relief. An easy way to bind two separate insulated wires together is to slip them through an eyelet and pinch the eyelet shank with pliers. To fashion a strain relief that will keep a wire from being pulled through a chassis hole, use two eyelets with their flanges facing each other and a washer between them. Lock the washer in place by pinching the shanks of both eyelets.



Wire-End Eyelet. Divide the conductor strands in the wire into halves and wrap around two sides of the eyelet shank. Twist the wire ends together to keep tight fit. Set eyelet with tool to lock in wire, trim off excess wire strands. The eyelet is a perfect fit on terminal bolts. For a rugged terminal eyelet sandwich the wire strands between two washers that fit snugly on the eyelet shank. Set eyelet and trim off excess wire.

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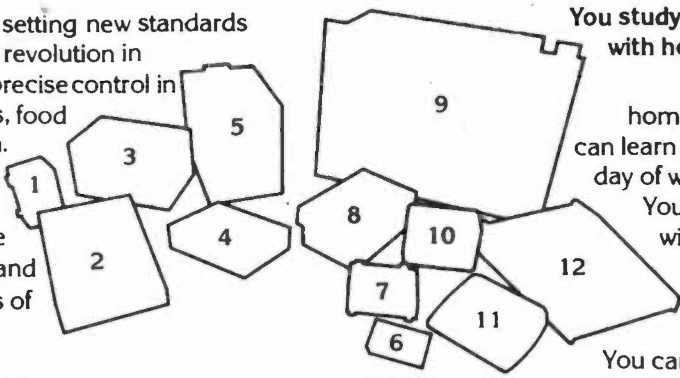

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DARKROOM PRINTING METER.

Print-paper saver gives you fine B&W prints sooner!

by Herb Friedman

TRY TO grind out wallet-size prints or enlargements from a full 36-exposure roll in only one evening and you'll know just how frustrating life can be. Every change in magnification and negative density means a different exposure. And if you use test strips or exposure guides to hit the correct exposure you're making at least two prints for every one you need.

The way to take all this drudgery out of your darkroom work is to use an electronic printing meter, a device that takes only seconds to indicate the correct exposure, regardless of whether the enlarger is at the top or bottom of the rack, or whether the exposure and negative development is over or under.

A quick example will illustrate how easy it is to make prints with a printing meter. Let's assume you have just chocked the negative in the enlarger and have cropped the picture exactly the way you want it. Now you take the probe from a printing meter—which you have previously calibrated for a 10 or 20-second exposure—place it on the easel at the point of maximum light transmission through the negative (the black reference in the print—deepest shadow) and adjust the lens diaphragm until the printing meter's pointer indicates some reference value you have previously selected.

That's the whole bit. Expose the paper for your normal 10 or 20-second exposure and the first print will be a good print. Maybe even a great print. If you're grinding out wallet-size jobs for the whole family, each print from each frame will have the same excellent quality.

A Hint. The key to successful use of a printing meter lies in the fact that, except for some particularly artistic work, any print will look decent to excellent if there is some deep black, even if it's just a spot of black; for the black to highlight or border-white contrast gives the visual appearance of a full contrast range, even if the greys are merged. For those who do portraiture, a printing meter can be user-calibrated for "flesh tones."

The printing meter shown in the photographs has been especially designed for construction and use by the typical e/e photographer/electronics hobbyist. It features a calibration—called "speed"—adjustment to accommodate slow to fast enlarging papers (such as Polycontrast and Kodabromide) and readily available parts, many of which will be found in the typical experimenter's junk box. The layout is non-critical—any cabinet can be substituted; there are no critical shielded circuits (not even shielded wire is used); and except for the photoresistor sensor, just about any component quality will do. There is absolutely no sense in building the project with the best components money can buy because the best components won't affect the final performance one iota.

Construction. The unit shown is assembled in a 5¼ x 3 x 5⅞-in. metal utility cabinet. Connecting jack J1 is optional as the photoresistor sensor, PR1, can be hard-wired into the circuit. If you use a jack, note that it must be the three-terminal type such as is used for stereo connections; the ground connection is not used since neither PR1 lead is grounded. Do not use an ordinary phone or phono jack as they will ground one of the PR1 leads. Plug P1 must similarly be a matching three-terminal stereo type. Either miniature or full-size jacks and plugs can be used.

Power switch S1 can be anything you care to use—lever, slide, or toggle. Use the least expensive slide switch if you're trying to keep the cost down.

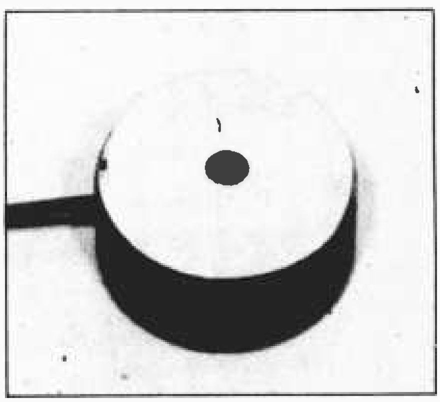
The meter, M1, is a Lafayette Radio 99-26262 illuminated 0-1 mA S-meter. This meter was selected because it has built in pilot lamps with 6 and 12-volt connections. When 12-volt-connected to T1, which is 6 volts, the pilot lamps are dim enough not to affect the sensor and bright enough so that you can see the pointer in the darkroom. Meter M1 mounts in a 1½-in. hole, which can be cut with a standard chassis punch (if you have the punch).

Sort Them. The meter scales are jammed with numerals that can be confusing in the darkroom so the best bet is to paint out the unwanted "calibrations" using Liquid Paper or Liquid KO-REC-TYPE, products used to correct typewriter errors (available in stationery stores). First, snap the plastic cover off the meter. It might feel secure but it's not. Grasp the top of the cover and force the cover outward and down, taking care that when it snaps free the pointer isn't damaged. Next, remove the scale by taking out the two small screws and sliding the scale out from under the pointer. Do not attempt to paint the scale while it is mounted in the meter as a single drop of the fast-setting correction fluid can ruin the meter if it gets into the pivot bearing. When reinstalling the scale, hold the screws with a tweezer or long-nose pliers until you "catch" the first few threads. When the scale is secure, snap the meter's cover into position. (On the unit shown all scales and markings other than 0-to-1 have been painted out, as the 0-to-1 scale is the most convenient to see under dim lighting.)

Note that meter M1, power switch S1, and jack J1 have been positioned on the front panel so as to provide the maximum room for the speed control's calibrated knob. Use the largest possible knob as the greater the calibrations the easier it is to reset the control to a desired paper speed.

Power transformer T1 can be any 6.3-volt filament transformer rated 50 mA or higher. (A 6-volt transformer scrounged from a portable cassette recorder will work just fine.)

Power Filter. If the line voltage in your home is known to be reasonably constant, assemble the unit as shown in the schematic. If your local utility likes to bounce the line voltage, or if appliances cause your line voltage to vary (indicated by dimming lights), install zener diode D5 across points A and B.

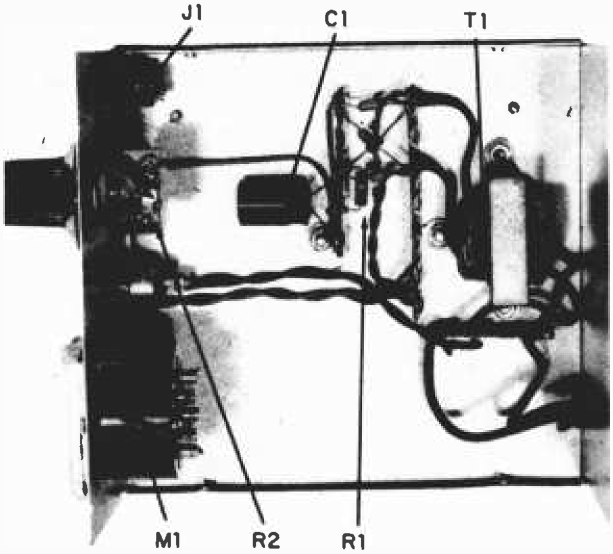


The sensor is really a large tuning knob with photoresistor PR1 embedded in epoxy, plastic or RTV rubber adhesive.

The zener will provide a regulated 6 volts, with the slightly lower circuit voltage (6 VDC rather than 9 VDC) providing slightly reduced sensitivity. Normally, you will not need D5, so there's no need to get it unless you're certain you need it.

In order to get speed control R2 to increase sensitivity in the expected clockwise direction, its ground terminal is opposite to the usual volume control ground. Facing R1's shaft with its terminals sticking up, the ground terminal is the one on the left.

Meter M1 has five terminals. The one designated "+" and the one adjacent to it are the meter terminals. The three terminals above the meter terminals are the pilot lamps. The extreme end pilot lamp terminals are the 12-volt connections. The center terminal is not used for the 12-volt connection.



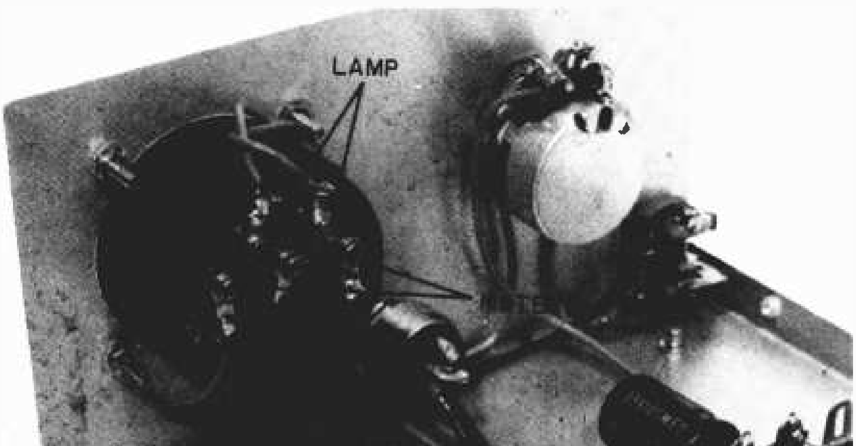
Nothing is critical so don't crowd the layout. Two parallel terminal strips provide the tie points for the rectifier diodes and power supply

The Eye. The only assembly that requires some care is the sensor. The sensor itself is a photoresistor; however, the photoresistor doesn't have enough heft to maintain its position on the easel, so it must be mounted in a support that can maintain its position without falling over. The sensor assembly shown consists of PR1 epoxy-cemented into a relatively large knob. The knob must be plastic—not metal, though it can have a metal decorative rim—and it's best if there is a recess on the top even if the recess is produced by a rim. Remove the set screw and drill out the set screw hole with a bit approximately 3/16-in. (not critical). Then, using a ⅜-in. bit, drill through the shaft hole clear through the top of the knob. If the shaft hole has a brass (or other metal) bushing make certain the drill bit removes all the metal.

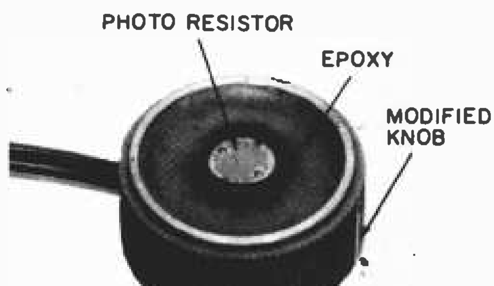
Pass the PR1 leads through the hole in the knob from the top. Tape it in position. Feed a section of linecord or speaker wire through the setscrew hole and solder the wires to PR1 as close as possible to the knob. Trim away the excess PR1 leads; they should not protrude below the knob. Remove the tape holding PR1, get PR1 as close to the center of the knob as possible, and then pour in a quantity of fast-setting epoxy or liquid plastic from a knob repair kit or plastic modeling kit, and let it set a few minutes until the plastic hardens. Keep the level of the epoxy or plastic below the top of PR1—use less rather than more. If you can't get epoxy or plastic you can use G.E.'s silicon RTV rubber (adhesive, caulk, window sealer, etc.); but the RTV rubber must cure for at least 24 hours. Similarly, pack the bottom of the knob with epoxy, plastic or rubber.

Mask Down. Now, the surface area of the photoresistor is too large for small prints—4 x 5 or smaller—and even some 8 x 10s. So cut a disc the diameter of the knob from shirt cardboard or a manila file folder (but not oak-tag) and using a standard hand punch (such as used in schools) punch a hole in the center of the disc. Apply rubber cement to the rim of the knob and the inside rim of the disc. When the cement is dry drop the disc on the knob so the hole exposes a small part of the photoresistor's surface. It's not all that critical; the hole doesn't have to be precisely over the center of the photoresistor. However, the unit is calibrated for a punch-size hole and might not work properly if the disc is not used, or if the hole is a hand made "pinhole." Use the punch.

Using the Meter. The first step is to select a decent reference negative and make a good print using a 10, 15, or 20-second exposure. We suggest 20 seconds as it will become your standard exposure, and will be



The specified meter has five terminals. The two on the bottom row are for the meter movement. The top row terminals are for the 12-volt lamp connection. The remaining terminal is for a 6-volt lamp connection and is not used.



After the sensor is completed, punch a hole in a matching cardboard disc and cement the disc over the sensor. The hole provides a smaller sensitive area required for prints 4 x 5 or smaller. Better results with larger prints are also obtained with the mask.

sufficiently long to allow moderate dodging. When you are certain you have a print exactly the way you want it, and without disturbing the enlarger's controls, place the printing meter's sensor under the *brightest* light falling on the easel—it produces black (maximum shadow) on the final print. Now turn on the printing meter and allow about five seconds for warm up. Adjust speed control R2 so the meter pointer indicates any meter reading you want to use as a reference. It doesn't matter what the reading is as long as you always use the same reference for the standard exposure time. For example, 0.2 on the meter scale is a good choice because it is well illuminated by the meter lamps. But you might just as easily select mid-scale as the reference meter reading. It doesn't make any difference; just be consistent.

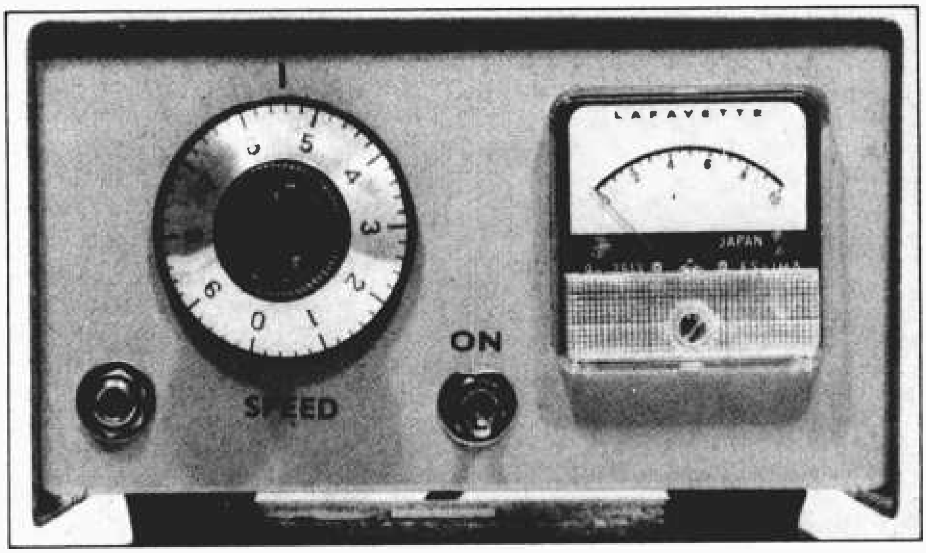
Once you have adjusted the speed control for the reference meter reading note on a piece of paper or in a notebook the dial reading from the speed control's calibrated knob. This is the reference speed value for the particular printing paper. For example, let's say you made the test print on Polycontrast using the #2 filter, and the speed knob indicates 5.6. Next time you want to print using Polycontrast with a #2 filter you simply set the speed knob to 5.6, put the sensor under the darkest shadow area and adjust the lens diaphragm for a reference meter reading. Everything will be set for your standard exposure time.

Changing Filters. Kodak provides a speed rating for all their papers and you can easily work out the correct (or close) speed control settings without making a "perfect" test print for each type and grade of paper. For example, changing from a #2 to #4 filter usualy means increasing the exposure by a 3.5X factor. If your #2 exposure is 10 seconds, the #4 exposure will be 35 seconds—somewhat long. You can, however, open up the lens diaphragm for a 3.5X light increase (close enough value) and adjust the speed control for the reference meter reading. The new speed control setting is the speed value for the #4 filter. You can do this with variable contrast filters or numbered printing paper.

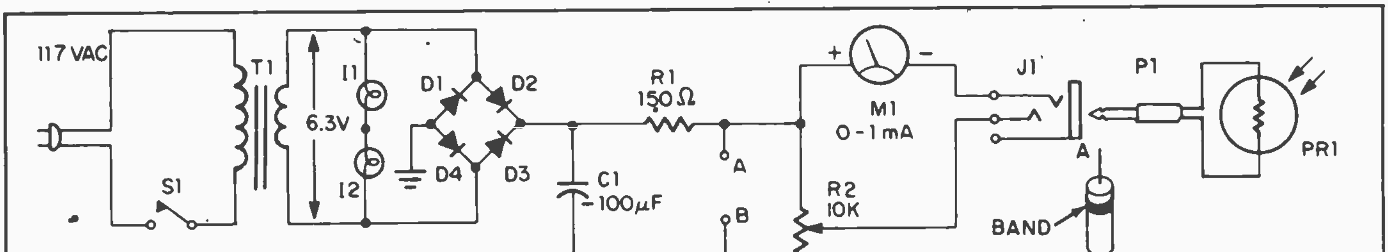
While the most pleasing print usually has some black, there are times when there can be no black, such as snow scenes, portraits, etc. You can peg the speed control's calibration to a grey corresponding to a skin tone, or any other degree of grey you might desire. The only thing you cannot do is calibrate the meter for highlights, since the meter might not have enough sensitivity for slow papers, and highlights can completely fool the meter.

If desired, you can take a speed control calibration reading for each type of paper (using your standard negative) for both shadow detail and intermediate grey. This way, you can quickly set up for typical snapshots, scenics, or portraits.

Keep In Mind. The sensor has a slight light memory, so we suggest the sensor be turned face down when not being used and the power switch be turned on and off in the dark, though you can keep the darkroom illuminated by a safelight with the power switch on. Meter readings, however, must be taken with all room lights off; only the enlarger should be on and the print meter should be positioned so that its meter lamps do not illuminate the sensor (even slightly). ■



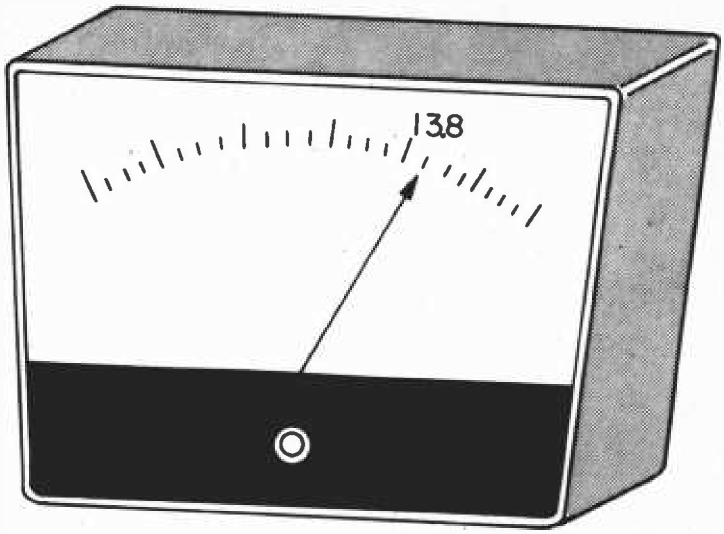
Use the largest calibrated knob you can install without interference by other panel components. The greater the calibration area on the knob the easier it is to preset the paper speed with accuracy.



C1—100-uF, 15-VDC or better, electrolytic capacitor
D1 to **D4**—1-amp, 50-volt silicon diode
D5—6-volt, 1-watt zener diode (optional, see text) (Radio Shack 276-561 or equiv.)
I1, I2—meter lamps, part of M1 (see text)
J1—3-circuit jack and plug set (optional, see text)
M1—0-1 mA movement, illuminated S-meter (see text)
PR1—photoresistor (National 4941 or equiv.)
R1—150-ohm, ½-watt resistor
R2—10,000-ohm audio taper potentiometer
S1—spst switch
T1—transformer: 117 volt primary, 6.3 volt at 50 mA or better secondary
Misc.—large knob for mounting photoresistor, case 5¼ x 3 x 5⅞-in., 5-lug terminal strips for mounting components, wire, etc.

The National 4941 photoresistor is available from the Electronic Hobby Shop, Box 192, Brooklyn, NY 11235 for $3.75 postpaid. New York state residents add sales tax; Canadian orders add $2 for extra postage. No foreign orders, please.

CB Power Mate for Maxi-Output



Here's the partner to power your mobile CB rig at home to its maximum capability—four watts RF output.

By Herb Friedman, W2ZLF

So you've just upgraded your Citizen's Band setup with a shiny new transceiver specified to give you four watts out—the legal maximum—or perhaps, if you've converted to the more efficient SSB (single sideband) operation, as many progressive CBers are doing these days, 12 watts, P.E.P. You've paid a couple of hunded dollars for this new equipment and are going to use it at home as your base station—even though it could be operated mobile, in your car, from its 12-volt system.

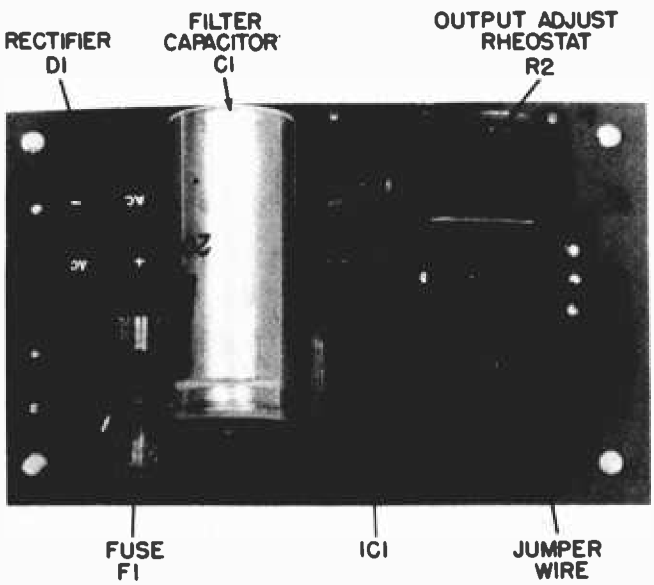
You hook it up to the 12-volt DC power supply you used at home with your old, lower-powered rig and it seems to work fairly well. You contact a few nearby CBers easily enough. But it doesn't seem to be getting out much farther than your earlier transceiver, which has considerably lower power output. What's wrong? Where did the power go?

You're probably not feeding the new set the 13.8 volts it was designed to get from the electrical system of your car when the generator is running, charging the battery, as well as powering the rest of the electrical system in addition to accessories like a mobile transceiver.

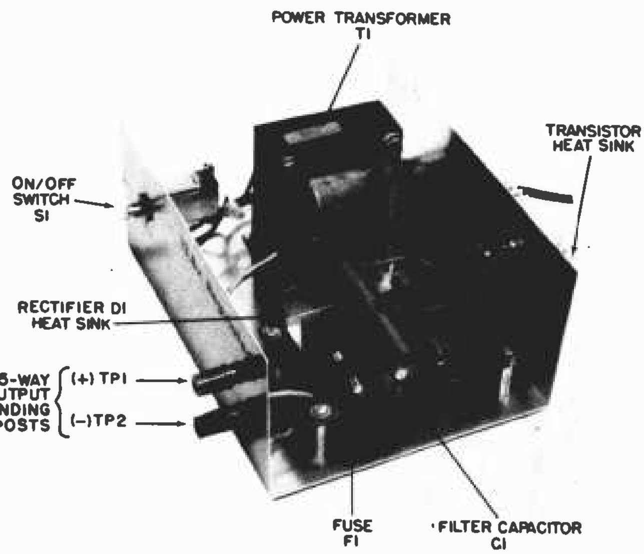
The 117-volt AC to 12-volt DC power supply you used with the earlier transceiver may have supplied it with current at 12 volts, but it can't provide the 13.8 volts, at higher current, which your new set needs to put its rated power on the air.

To be sure, check the actual power supply voltage you're feeding to the CB set.

What Voltage? To check the actual output of your old power supply, get out your voltmeter and measure the voltage being fed to your transceiver. It probably reads around 12 volts (maybe a bit more when the transceiver isn't turned on). You turn the CB set on to *Receive* and get a good solid 12 volts (or maybe as high as 13). So far so good. Now switch the set to *Transmit*.



13.8-volt regulator parts mounted on circuit board. Low-powered (1.5 amp) model does not require heat sink for rectifier.



Complete CB Power Mate, top removed. Higher-current (3-amp model), with U-shape heat sink (homemade) for rectifier. Large heat sink on rear is for transistor.

CB POWER MATE

The input power voltage drops to around 10 volts! Turn it off.

That power supply might have been OK with a lower-powered unit, but it just doesn't make it with this higher-powered job. The four watts of transmitting output you paid for when you bought this new rig is only 2.5 to 3 watts now. This is because your power supply hasn't got the output *voltage regulation* it needs—the ability to put out constant voltage, within its specified limits, regardless of variations in the required current. In addition, your mobile transceiver was designed to work from a DC power supply of 13.8 volts; when the car is running that's what it gets, to charge the battery. (Ever notice how the lights are dimmer when you run them without the motor turning over? That's the difference between 13.8 and 12 volts (or even less, if your battery is on low charge or about to conk out with a weak cell).

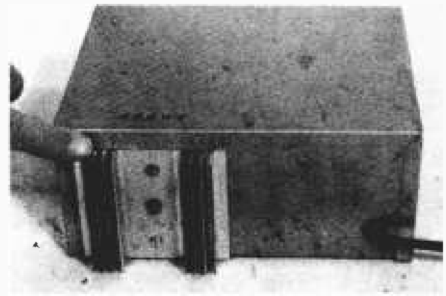
It's Only 1.8 Volts. "So what's 1.8 volts?" some people may ask. "Most electronic components are manufactured to a tolerance of 10%, and we see that most schematics have their voltages specified "± 20%."

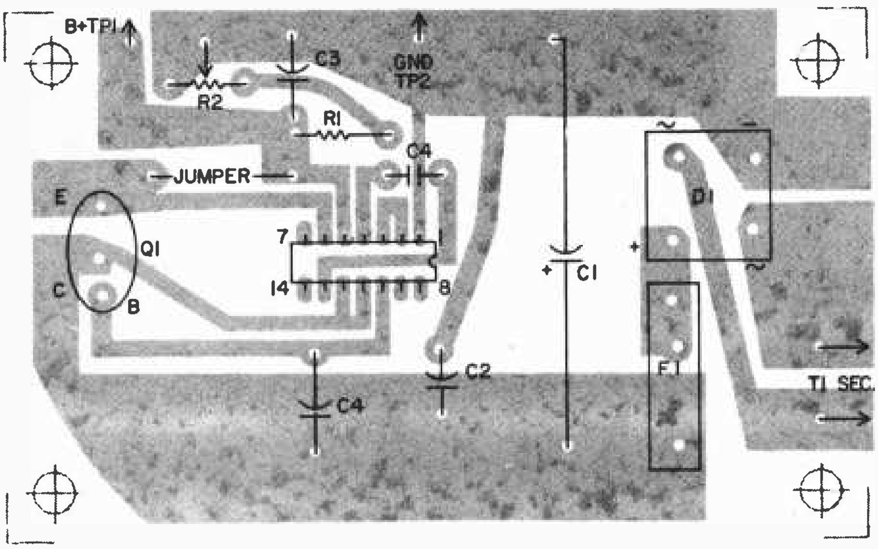
Won't most equipment and circuits operate over a wide range of voltages from their power supplies? Yes, they will often operate, in many cases quite well, but not power output circuits. They just won't deliver the specified output. Equipment which draws substantial current can only produce its rated output when it gets power at the voltage specified by the design engineers. The difference between 12.0 and 13.8 volts amounts to 15% less transmitter power. If the supply puts out only 10 or 11 volts when it's under a heavier-than-usual load the loss can be as high as 25 percent. It could be a lot less. If that power supply's output regulation is so poor that it puts out only eight or nine volts with your new CB transceiver the transmitter might not work at all.

To insure maximum performance from your mobile transceiver when powering it with AC house current, you must use a 13.8 volt *regulated* power supply. Regulation provides exactly 13.8 volts under a wide variety of loads—from full load to no load—and also compensates for AC line voltage fluctuations if they occur.

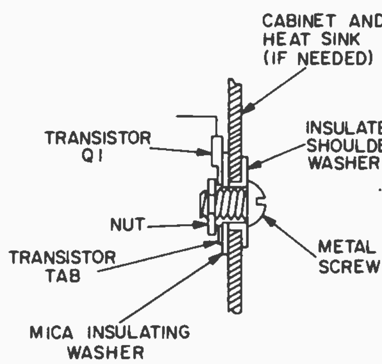
Although a regulated supply can cost from $50 to $100, you can build the *CB Power Mate*, as shown in the photographs for about $20 to $25 (or even less if you're good at scrounging parts or have a junkbox of used components). The same supply can be used as an AC-to-DC power source for high power walkie-talkies (one-watt or more output) which require exactly 12 volts, because this supply can be adjusted at the flick of a finger to any mobile power voltage—even six volts. Your regulated supply can be built to handle any current needed, up to three amperes. The current capacity is determined by the output of the power transformer, T1, and filter capacitor C1, the two most costly items in this project. Thus you can save money by building only the current capacity you actually need.

Front view of CB Power Mate shows On/Off switch, red (+) and black (—) power output binding posts. Rear view of higher-powered version has finned heat sink to dissipate heat from regulating transistor. Quarter-inch holes are for ventilation.





Copper side of printed circuit board. You can make it easily from kit purchased at electronic parts stores. Position of parts shown actually are located on back side of board. See full size template in story.



How to mount transistor to dissipate heat into metal cabinet (and external heat sink, in 3-amp model). Use silicone grease on both sides of insulating mica washer. Tape over screw head (outside case) to protect against external short.

How It Works. The first section of the CB Power Mate (the 117-volt step-down transformer T1, the rectifier, and the large capacitor, C1) supplies *unregulated* current at between 15 and 35 volts, depending on the number of turns in the secondary of T1. The rest of the supply is the regulator section. The size of the voltage drop across the regulator depends on the resistance of transistor Q1, which varies according to its base bias. The bias is controlled by the action of the IC, which gets its commands from the voltage applied to pin 4. This voltage is taken from the junction of R1 (1800 ohms) and R2 (500-ohm rheostat), which are a voltage divider across the power supply output. Initially R2 is set to provide the desired voltage—13.8 or whatever—at the emitter of Q1 (the supply output).

When the load (the transmitter) starts to draw more current, the voltage at the power supply output begins to drop. This lowers the voltage at IC pin 4. The IC then applies a higher (more positive) voltage to the base of Q1 (IC pin 10). Since the transistor is an NPN, the positive-going base signal lowers Q1's collector-emitter resistance, increasing the collector current and raising the voltage at the emitter (power supply output). When a change in load draws less current, tending to raise the supply voltage, this increase is sensed by the voltage divider, which now applies a lower (more negative; less positive) voltage to IC pin 4. This increases Q1's collector resistance, lowering the voltage at the supply output.

This all takes place almost instantly, so the output voltage remains steady, at the value at which it was originally set. This happens even though the transmitter current (the load) is changing all the time.

Two Versions Can Be Built. The schematic diagram shows the supply for loads up to three amperes at 13.8 volts. For lighter loads, up to 1.5 amperes (still 13.8 volts) capacitor Cx is not needed, and the power transformer can be a lighter, less expensive one. In addition, capacitor C1 can be rated at 25 VDC, instead of the 35 or more required for the higher-powered version. Also, the smaller power supply doesn't need heat sinks for the bridge rectifier and the series transistor (also called a "pass transistor") because all the current used by the transceiver passes through it.

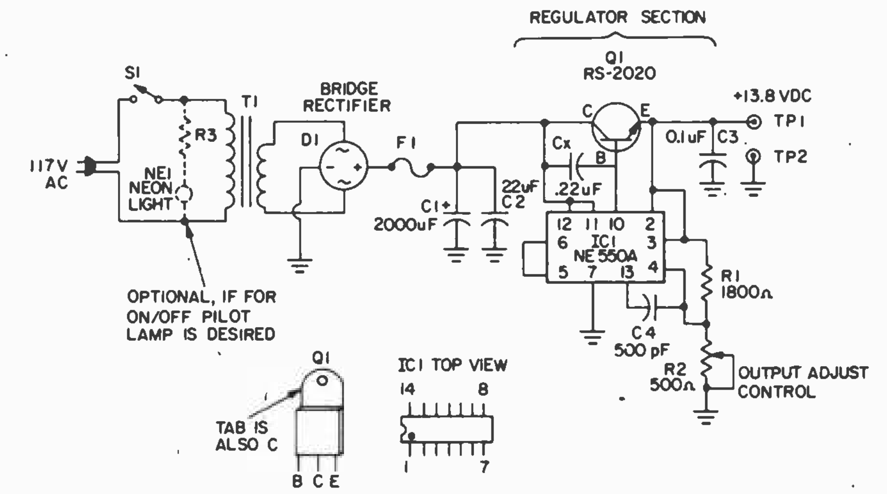
Check the Voltage. First you should find out what the power requirement of your transceiver is when you are transmitting. It will usually be one amp or more (*receiving* will take much less current). It may be as high as 2.5 amps. Once you know how much current your transceiver needs, you'll know whether to build the model which supplies up to 1.5 amps or the three-amp one. Now take the parts list and check your junk box for parts you can use.

Construction. The heart of the CB Power Mate is the regulator, which consists of integrated circuit IC1, series regulating transistor Q1 (which is controlled by IC1) and their associated resistors and capacitors. C1 is the main filter capacitor, which initially smooths the varying DC supplied by the bridge rectifier from the AC output of the power transformer secondary.

The printed circuit board, which you can easily make with a kit from any parts distributor, has been designed to work in either the 3-amp model or the 1.5-amp unit. The photograph showing the board with its components mounted is the lowered-powered one. The completed supply pictured is the higher-powered unit. You can see that the assembled boards for both versions are almost identical. One difference is that the 3-amp supply (completed unit) has a piece of U-shaped aluminum you can bend to make the heat sink for the bridge rectifier. This is not needed for the lower-current supply. The photograph of the completed unit also shows the fins of the large heat sink for the transistor mounted on the back of the box behind the transistor. This heat sink isn't needed in the 1.5-amp power supply.

Fuse F1 is a fast-acting type which protects the bridge rectifier and the power transformer from blowing out if you should make a wiring error or short-circuit the output. The fuse listed will blow out before the components, so don't use any other kind of fuse, even if it has the correct current rating (three or five amps). Use only type AGX, not slow-blo or 3 AG. Try to get a fuse-holding clip made for soldering to the printed circuit board. That kind is easier to install than those which mount with screws.

Solder the pins of the 14-pin IC socket to the board, but don't insert the IC into its socket until the socket has cooled off. Heat can ruin an IC or a tran-



Ultra-simple circuit delivers regulated output.

PARTS LIST FOR CB POWER MATE (3-AMPERE MODEL)

C1—2000-uf, 35-VDC electrolytic capacitor
C2—0.22-uF, 100-VDC capacitor
C3—0.1-uF, 100-VDC capacitor
C4—500-pF, 100-VDC capacitor
Cx—Same as C2, above
D1—Bridge rectifier diode package, 6-amp rating, 100 PIV (peak inverse volts)
F1—Fast-acting fuse, 5-A rating
IC1—Voltage regulator integrated circuit NE550 (DIP package, International Crystal Mfg. Co., 10 N. Lee St., Oklahoma City, OK 73102. NE550, or equiv.)
Q1—NPN silicon transistor (Radio Shack RS-2020 or equiv.)
R1—1800-ohm, ½-watt resistor
R2—1000-ohm printed circuit (end mounting) potentiometer
S1—SPST power switch, 120 VAC. If self-illuminating switch with built-in neon light is desired, use Radio Shack 275-671 or equiv.)
T1—Power transformer, 117-120 VAC primary, no center tap needed. Secondary 18 to 21 VAC at three amperes (Allied Radio 705-0133 or equiv.)
TP1, TP2—Binding posts, 5-way, one red, one black
Misc.—Printed circuit board materials, or perf board; fuse clip for mounting on PC board; heat sink for transistor Q1; heat sink compound (Radio Shack silicone grease 276-1372 or equiv.); IC socket for integrated circuit IC1 (Radio Shack RS276-027 or equiv.); scrap aluminum piece approx. 1-in. x 3-in. x ⅛-in. thick; standoffs (aluminum) four, ½-in. for mounting pc. board (Radio Shack 270-1394 or equiv.) with machine screws, nuts, and lock-washers.

PARTS LIST FOR CB POWER MATE (1.5-AMPERE MODEL)

Use all same parts as above, except for the following changes:

C1—Same, or use 25-VDC rating, which costs less
C2—Cx is not needed
F1—As above, except 3-ampere rating
T1—As above, except 12.6 to 16 VAC, at 1.5 amperes (Allied Radio 705-0121, or equiv.)
Heat sink for transistor not needed
Scrap aluminum for heat sink not needed

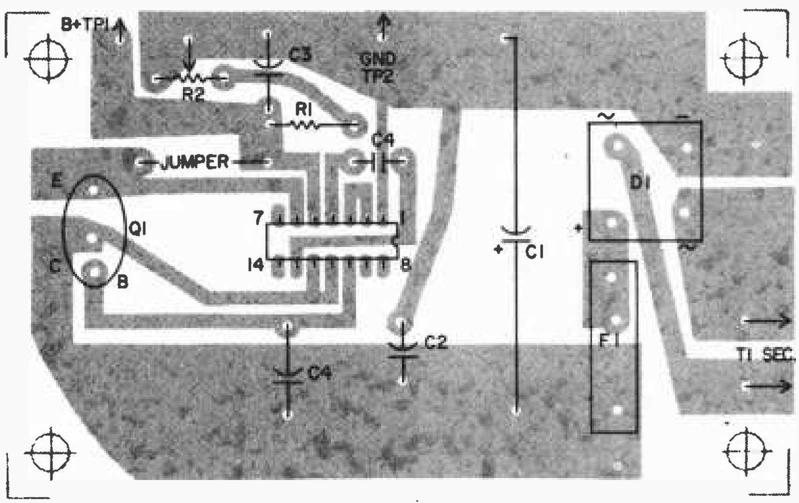
sistor. Also be sure to hold each transistor lead with a pair of long-nose pliers as a heat sink when you solder to the transistor leads.

For the high-current CB Power Mate the bridge rectifier has a hole in the center to which you can secure the homemade heat sink. To make this, take a piece of scrap aluminum the width of the sink or larger and bend it in a U-shape with the ends sticking up in the air about an inch. Secure the sink to the rectifier with a #6 screw, a lockwasher between the screw and the rectifier, and a lockwasher and a nut on top of the heat sink. (The screw feeds in from the terminal or lead side of the rectifier.)

Also, for the high-current Power Mate the transistor uses the special heat sink with fins on the back of the cabinet (as shown in the picture). Q1 is installed the same way for both models. Drill a ¼-in. hole through the sink and the cabinet. Bend Q1's leads outward, away from its mounting tab. Using a mica insulator from a power rectifier (preferably) or a power transistor mounting kit, coat both sides of the mica with silicone heat sink grease. Position the insulator over the hole in the cabinet and place an insulated shoulder washer (from a 5-way binding post) in the cabinet hole, from outside the cabinet, and pass a #6 screw through the sink, the cabinet, and the mica insulator. Then install Q1 and a lockwasher and a nut. Tighten the screw slightly more than hand tight. Check with an ohmmeter to be sure there's no short between the tab of Q1 and the cabinet. You should read infinity—no connection. If you have a short (one ohm or less) look for an improperly-seated shoulder washer or for a metal chip from the drilling.

Final Assembly. Before final assembly, with the parts *not* mounted in the box, drill a row of five ¼-in. holes in the cabinet directly over Q1, and five more holes in the lower left of the cabinet, near the transformer. These will provide adequate ventilation. Then put a small piece of tape over the head of the screw which secures the transistor, to prevent a (possible) external short.

Complete all wiring before installing the IC. Plug it into its socket so that pin 1, which has a dot molded next to it, faces the edge of the printed circuit board farthest away from the rectifier. Pin 1 should be toward the wires going to the board from the transistor. Install the fuse in its clips, set the rheostat,



Exact-size template for printed circuit board you can make. Location of holes for integrated circuit are critical—exercise care in drilling.

R2, to its mid-position, and connect the voltmeter to the output of the power supply (the binding posts). Plug in the CB Power Mate's AC cord and observe the meter. It should rise to some value and stay there. If it wanders, or rises and falls back down to zero, disconnect the AC power and check for a wiring error. If the voltmeter remains steady, adjust R2 very slowly for the desired voltage, 13.8 volts (or 12, or whatever depending on the set you are going to power with it). That's it—your CB Power Mate is ready to use.

Optional Protection. If you want to build-in the *maximum current limiting* (to make sure the supply will turn off if a short suddenly appears outside it), you can substitute a resistor for the jumper on top of the board. To figure the value of the resistor, follow these steps:

1. Find the value in ohms of the resistor, which we will call "R." The formula is: $R=\frac{0.6}{X}$ where "X" is the current the transceiver draws when transmitting.

2. If the current is 2 amps, then the formula gives us: $R=\frac{0.6}{2}=0.3$

3. Now we must find the power rating of the resistor. Power is $W = I^2R$, where I is the current. Since we know that R is 0.3 ohms, and that the current is 2 amps, we get: $W = 2 \times 2 \times 0.3$ or $W = 4 \times 0.3 = 1.2$ watts. For safety we double the rating, giving us 2.4 watts.

4. So, we need a 0.3 ohm, 2.4 watts (or more, since that exact wattage isn't available). The nearest larger wattage rating should be used. Two 0.6 ohm, 2-watt resistors in parallel would do nicely.

In Use. Now plug your CB Power Mate in: connect the positive and negative leads of the 13.8-volt power supply to the Plus and Ground connections on your transceiver and start contacting your fellow CBers . . . with the maximum legal power which you paid for with your new set. Why not get it?

Of course the CB Power Mate is only needed in your home. In your car the transceiver will be getting the 13.8 volts it needs, if that electrical system is operating correctly.

Caution: Don't try to use the CB Power Mate at settings higher than 13.8 volts with a transceiver which requires that voltage. Trying to increase a transmitter's RF power output that way will probably result in blowing out components in the transceiver, because many transceivers are designed to just accept 13.8 volts, with not much safety factor above that. Be sure the Power Mate is set for exactly 13.8 volts before you turn on the transceiver, not any higher.

If you're not certain that your voltmeter is reading DC volts accurately, you can calibrate it very closely by using several new flashlight cells (not nicads—just ordinary, good condition—tested in flashlight—batteries). These cells, in good condition, put out exactly 1.56 volts each. Four cells in series should read 6.24 volts. 8 x 1.56 V = 12.48 V. Or you can get 13.94 V from nine cells. ■

THREE SHORTCUTS TO YOUR FIRST SHORTWAVE ANTENNA

by Hank Scott

BEGINNERS to the shortwave listening (SWL) hobby have no difficulty in obtaining good receivers, either budget jobs or gold-plated specials, when starting their first listening shack. Putting up antennas is their downfall.

Antenna theory is beyond the grasp of most novices. It is very complex at the beginning and rapidly becomes incomprehensible as different antenna types are introduced. So, why not take a shortcut approach to your first antenna installation. Get your new receiver pulling weak signals as you pile up listening hours with exotic DXing. What about antenna theory? It'll come if you work at it by reading theory books, but in the meantime here are three recorded case histories to low-cost antenna shortcuts which may be profitable.

Case No. 1—The Dangler. Harry is a youngster I met while giving a talk to the local high school student body during Science Fair Week. Harry was fascinated by the idea of English language newscasts from far-away places, so he bought a Realistic DX-160 receiver and set up a listening corner in his upstairs room in his folks' Colonial-style house. For an antenna, he dangled an odd length of wire out the window, letting it drop to the ground. The BBC and Radio Moscow came in fine except on rainy nights. In fact, it was a rainy evening when he rang my doorbell for help.

Harry's long wire was long and that's all it had going for it. It was vertically polarized (wrong) by hanging down and shorted out to ground (not good either) on damp nights. What Harry needed was a length of wire extended from the window to a distant pole, outbuilding, garage, or tree. In Harry's case, some sturdy trees outlined the houses's property line and he could run a 60-foot antenna with no difficulties. The antenna pointed due North-West and in his area of the U.S. was able to pull in Europe, North Africa, and the Near East with ease. Here's how we went about licking Harry's problem.

First, I told Harry that a good long-wire antenna should be at least 30 to 100 feet long for good reception performance on 2 to 30 megaHertz (MHz). As mentioned earlier, a 60-foot run was possible. A sturdy tree was selected because it hardly swayed in strong winds at the 20-foot level where the antenna would be secured. Some slack (one foot of droop) was left in the antenna to compensate for tree sway and strong winds. Harry's antenna details can be seen in Fig. 1.

Antenna wire and antenna long wire kits are available everywhere. Harry actually used the Radio Shack shortwave antenna kit (278-758) which consists of 75 feet of bare copper antenna wire, 50 feet of lead-in wire, four insulators, and instructions. Harry had no trouble at all getting the antenna up.

Harry was a little smarter than me. He remembered to protect against lightning. Since shortwave lightning arrester kits are usually not available locally, Harry made do with lightning arrester parts made for TV. The parts available from Radio Shack include the arrester (15-911), ground rod (15-530), 40 feet of aluminum wire (15-035), and other small parts. The TV arrester has two screw-tight terminals with star washers for the 300-ohm TV line, however Harry only used one for his antenna and the other was left unused. The whole lightning installation bit came to about $5.00. That's cheap. To bring the antenna lead-in into the house, Harry used a "Wall-Thru" tube

FIRST SHORTWAVE ANTENNA

(Radio Shack 15-1200).

Now I don't see much of Harry. Maybe once in a while he's at the Pizza joint with a date, but you can be sure Harry's getting a lot of DXing and veries every week.

Case No. 2—The Specialist. I've known Mort for over 20 years. We knocked about through high school and somehow the paths of our lives are forever crossing. At one such juncture, Mort invited me to his home to see his new shortwave listening shack which sported a brand-new freshly assembled Heath GR-78 receiver. The GR-78 is a hot receiver. Unfortunately, I couldn't say the same for Mort's antenna. Mort was always inclined to specialize, and he had rigged up a dipole antenna with 300-ohm TV antenna lead-in wire. Mort wanted to log the 41-meter band and found it offered poor reception in his area. Besides, the noise was too high. He was asking, if not pleading, for advice.

First of all, I told Mort that dipole antennas are cut to exact dimensions for specific frequency bands as shown in Fig. 2. The dipole consists of a wire of a specific length which is cut in half. At the mid-point and both ends, each half of the wire is insulated from each other and insulated from ground. The lead-in cable from the antenna is actually two wires, and it's best to use a 73-ohm coaxial cable (coax) because it is inexpensive and commonly available. Without getting into theory, let me say that a 73-ohm coax lead-in cable "matches" a dipole antenna with less signal loss than does a 300-ohm TV twin-lead cable. On the design board, dipoles have a 75-ohm impedance and match pretty well into 73-ohm coaxes. The 300-ohm cable Mort was using was a bust.

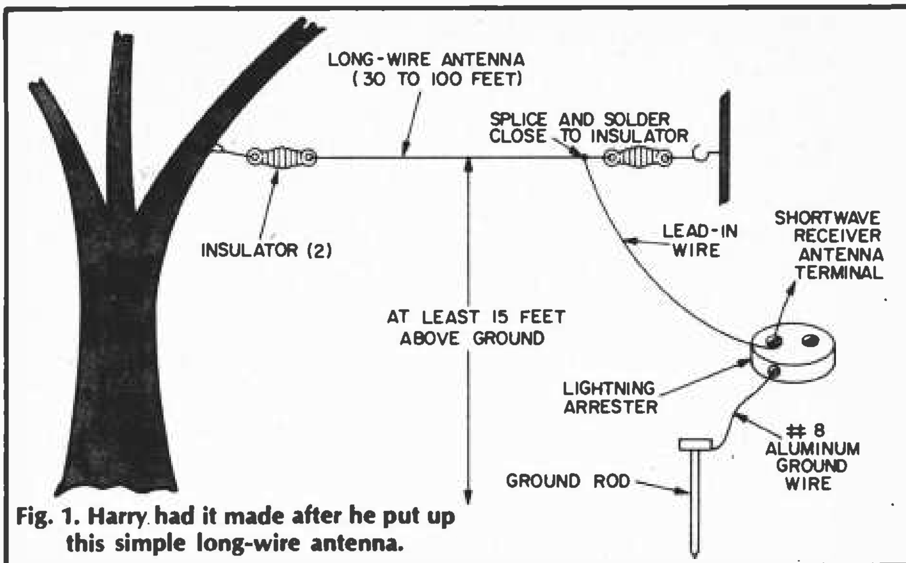


Fig. 1. Harry had it made after he put up this simple long-wire antenna.

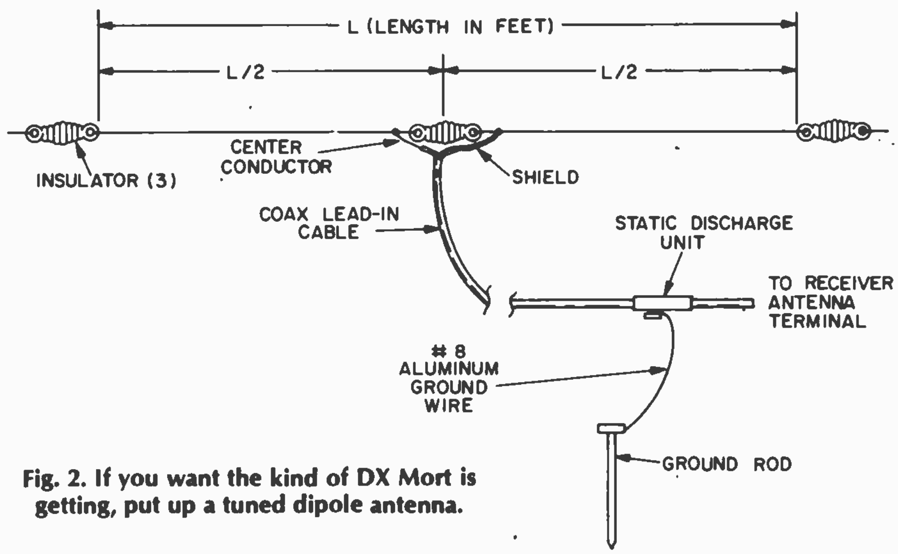


Fig. 2. If you want the kind of DX Mort is getting, put up a tuned dipole antenna.

The equation for determining the overall length for a dipole antenna at a given frequency is determined by dividing the given frequency in kiloHertz into the number 468,000. Or, as seen in the text books:

$$L = \frac{468,000}{f}$$

Where L is the overall length of the dipole in feet and f is the desired reception frequency in kiloHertz (kHz). I computed the overall length for dipole antennas to receive the international shortwave broadcast bands using the mid-frequencies of each band and listed them in a table that appears on this page.

When buying materials for a dipole antenna, wire and insulators are the same type as required for the long wire antenna. The lead-in coaxial cable should be RG-59/U or RG-11/U, each of which exhibits 73-ohms impedance. Stay away from unknown coax types or those with different impedances (ohms). As a guide, a table given on this page lists commonly available coax cables and their impedances. Any coax exhibiting an impedance in the 70's is good for the purpose. Let price dictate your selection.

I did not forget the lightning arrester in Mort's antenna. At the window, out of reach of the rain, I installed a Radio Shack coax static discharge unit (21-1049). This gadget requires PL-259 connector on the coax lead-in cable. It's worth the trouble. A grounding screw on the connector attaches to the

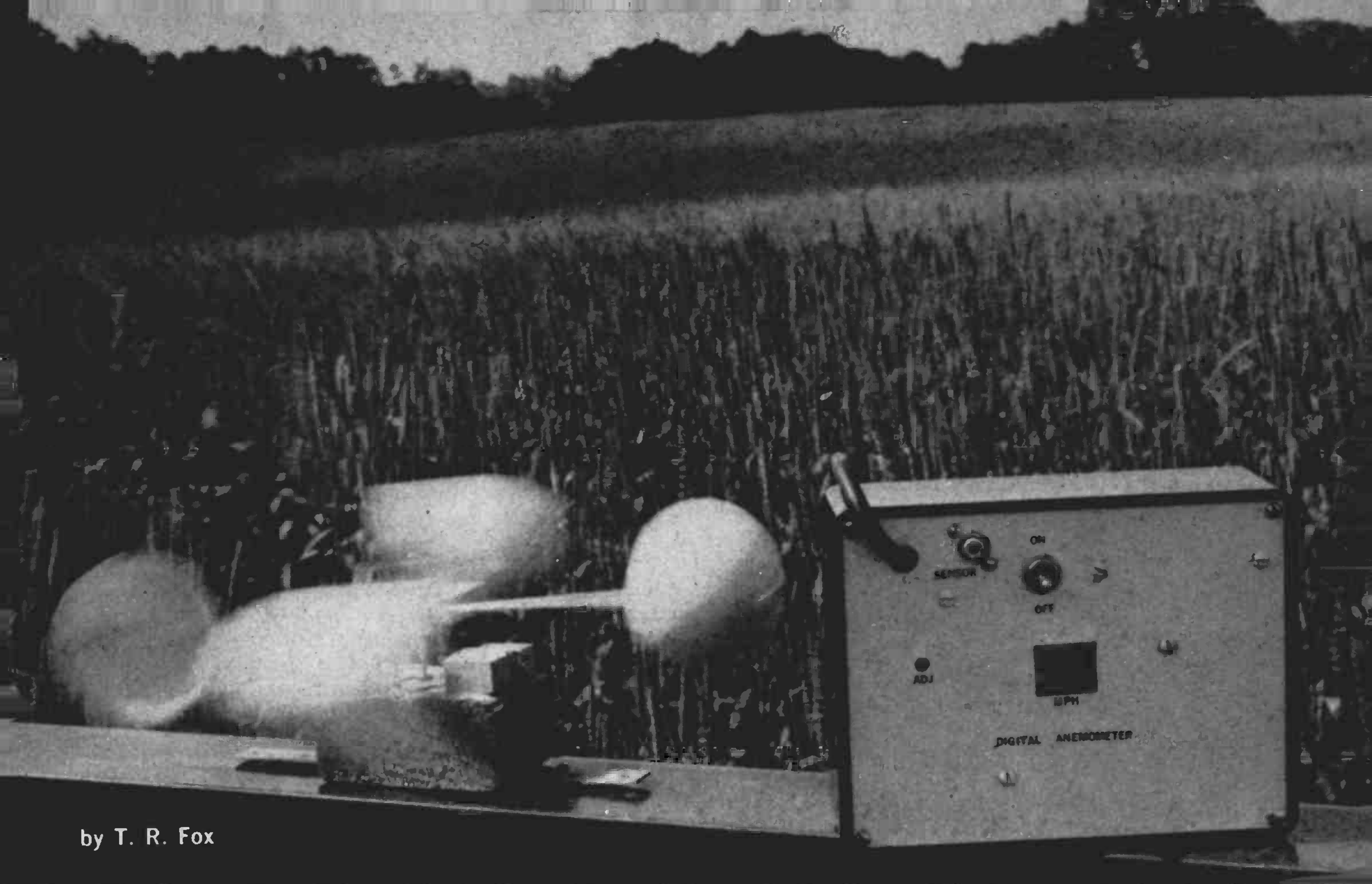
(Continued on page 103)

Dipole Overall Length for the Shortwave Broadcast Bands

Band	Frequencies (kHz)	Mid-Frequencies (kHz)	Length (feet—inches)
120	2300-2495	2397.5	195—2
90	3200-3400	3300	141—10
75	3800-4000	3900	120—0
60	4750-5060	4905	95—5
49	5950-6200	6075	77—0
41	7100-7300	7200	65—0
31	9500-9775	9637.5	48—7
25	11700-11975	11837.5	39—6
19	15100-15450	15275	30—8
16	17700-17900	17800	26—3
13	21450-21750	21600	21—8

Coax Lead-in Cable

Cable Type	Typical Ohms
RG-11/U	75
RG-59/U	73
RG-59A/U	75
RG-59B/U	75
F-11/U	75
F-59/U	73



by T. R. Fox

MEASURE THE WIND!

Easy-to-wire, accurate, anemometer uses ICs and LED-readout.

Increasing energy costs have driven many people to thinking of alternate sources of power, such as solar energy and water power. But the technology for these natural energy sources is still quite expensive and complicated to install. It'll be at least several years before the cost of most natural energy systems comes down enough and the parts are easy enough for most people to install. Wind power for generating electricity, on the other hand, has been available for many years. For several decades farmers and others in rural areas have used windmill generators as standby electricity and in some cases, as their main power supply. Windmills and wind-driven electrical generators can be bought off the shelf by anyone, and require no expertise other than the usual home mechanic skills to set up.

Have you wondered if there's enough wind where you live to drive a windmill electrical generator? Do you know if there's enough wind to fly that big kite you've often thought of constructing? Is there enough wind coming over the hills near your area so you can get into hang-gliding? Or do you live in an area where tornadoes or hurricanes sometimes strike? If so, it could literally be a matter of life-and-death for you to read the windspeed easily, with an accurate, easy-to-install anemometer (windspeed meter). That's what the Digital Windspeed Meter is—an accurate anemometer using the latest digital TTL (transistor-transistor logic) integrated circuits.

Though this project isn't recommended for someone who's never built any solid-state projects before, it should be easy enough for anyone who has built one or two simpler projects such as most of those published in *Electronics Hobbyist*.

In addition, it's the sort of project which will get you started easily in digital logic circuitry, the circuits and components which are the basic building blocks of computers and most other advanced electronics today.

How Anemometers Work. There are two types of electronic anemometers in general use. One type uses air cups or a wind turbine to turn a tiny electric generator whose output is directly connected to a milliammeter. The faster the wind blows, the faster the generator turns and the higher the meter reads. This type of anemometer is simple and reliable but it usually is not accurate.

A more sophisticated type uses air cups to turn a shaft to produce electric pulses. The pulses are integrated by a capacitor and related circuitry to produce a DC voltage whose magnitude is directly proportional to the wind speed. This voltage is aso displayed on a meter. This method is easier to calibrate, and thus is more accurate than the simple generator method. By

DIGITAL WINDSPEED METER

using state-of-the-art digital electronics, improvement can be made upon this method of measuring the wind's speed. Instead of the round-about method of adding up the electric pulses by charging up a capacitor, why not just count them directly? The digital anemometer described here does just that. The result is a more accurate sophisticated instrument that is easier to read and cheaper to build.

How It Works. The theory behind the digital anemometer is simple. See Fig. 1. The wind turns a shaft which has streamlined plastic cups attached to it. On one rod that holds two oppositely directed cups are placed two small magnets. A reed switch is mounted on the stationary base beneath the rotating cups so that it will be operated by the rotating magnets above. Each time the cups make a full revolution, the reed switch opens and closes twice. The pulses generated by this reed switch trigger a one-shot multivibrator (TTL-7412) which cleans up the pulses, eliminating contact-bounce and other error pulses. The cleaned-up pulses are then fed to a TTL NAND gate which is controlled by the 555 one-shot multivibrator. The 555's one-shot output pulse is manually adjustable to let us calibrate the anemometer. Another 555 astable multivibrator provides automatic triggering pulses for the 555 one-shot as well as supplying reset and blanking pulses for the counters and decoders. The resulting controlled and cleaned up pulses (which originated in the reed switch) are counted on two TTL decade counters and displayed on two LED displays.

Construction. The rotating wind sensor is made up of 4 plastic cups, mounted with 5/32-in. or 1/8-in. rods to a slot-car motor or similar cheap and readily available bearing. (The brushes of the motor can be removed if desired.) The egg-shaped containers in which *Leggs* nylons are sold are ideal for the plastic cups which catch the wind.

The rods which support the cups can be steel welding rods or (better) copper or brass. One rod should be one foot long and the other two should be six inches long.

Next, obtain a small cylindrical piece of a solid metal that is easily solderable —brass or copper is best. Drill two holes, using bits the same size as the rods, at right angles to each other through this cylinder of metal as shown in Fig. 2.

Now center the 12-in. rod in the cylinder. Insert the two shorter rods in the remaining two open holes in the cylinder, as shown in Fig. 3. Using acid-flux, solder the rods to the cylinder.

Mount the motor, which is used as the bearing, in a 2-in. long piece of two-by-four. To mount the motor, drill and file a hole in the wood large enough to take the motor. Cover the motor's case with epoxy glue and insert it in the hole as shown in Fig. 4.

Using a bit as close to the diameter of the motor's shaft as possible drill a hole about ½-in. deep in the bottom of the cylinder (see Fig. 3) which now has rods soldered to it. Insert the motor shaft into this hole and solder it, using acid-core flux.

(If steel is used, secure with epoxy glue.)

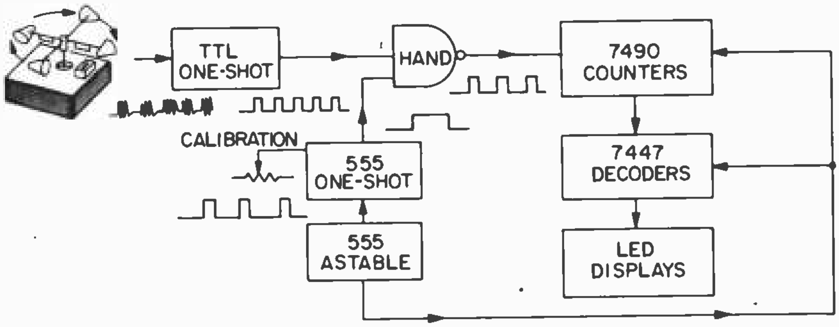


Fig. 1—Block diagram for digital anemometer. As the calibration control is varied it changes the duration of the pulse put out by the 555 one-shot. This acts as a variable window for the pulses coming from the windspeed sensor permitting accurate readout of the LEDs.

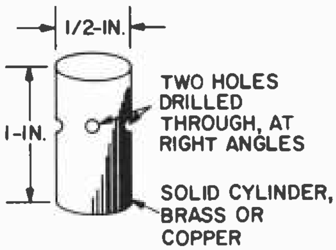


Fig. 2—Centerpiece of windspeed sensor.

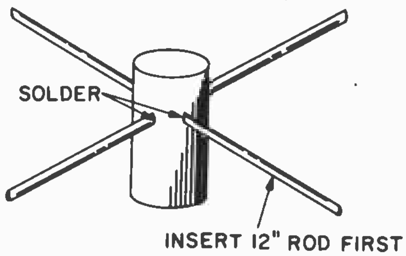
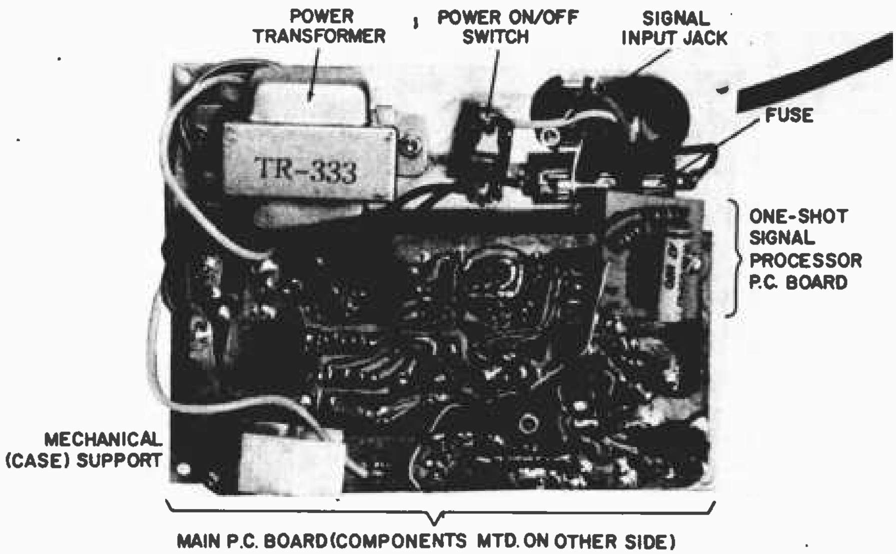


Fig. 3—Assembly of rods and centerpiece to form rotor.



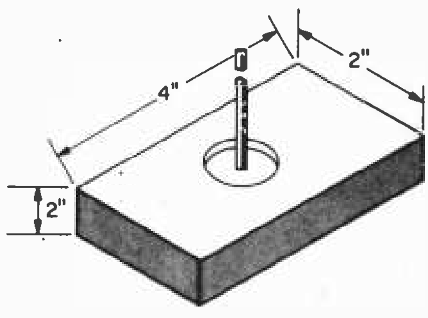


Fig. 4—Wood block mount with bearing.

Now mount the four plastic cups to the rod, taking care to correctly orient the cups. Drill holes in the cups and insert the rods in the holes. Keep the cups in place with epoxy or other good glue.

Next we mount the magnets on the rods. If copper or brass rods are used, great, just solder or glue the magnets to the undersides of two opposite rods, centering them one inch from the pivot. The reed switch is then mounted on the wood base so the magnets pass a quarter of an inch above it.

If the rod is iron or steel, we have a problem because it will distort the magnet's magnetic field. This problem is overcome by using a non-magnetic spacer between the magnet and the rod —¼-in. is enough space. A ¼-in. x 1-in. piece of wood is glued to the rod and then the magnet glued to the wood. Since there is very little weight involved, a good glue will hold the magnet fine. This completes the construction of the wind sensor.

Circuit Assembly. To build the cir-

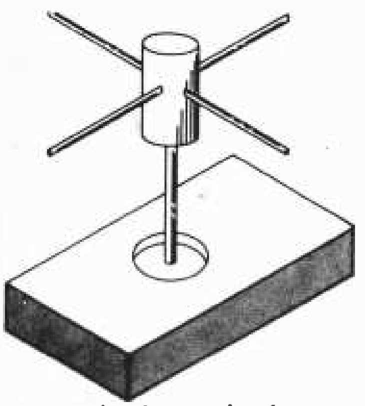


Fig. 5—Rotor in place on bearing.

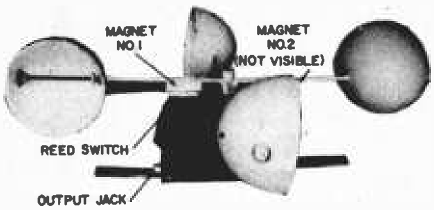


Fig. 6—Completed unit. Adjust height of reed switch so magnets pass about ¼-in. over it or less.

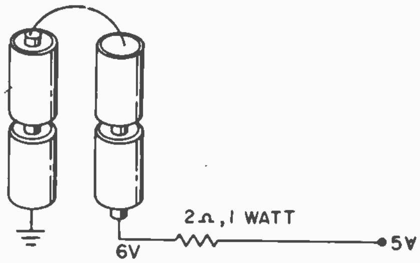
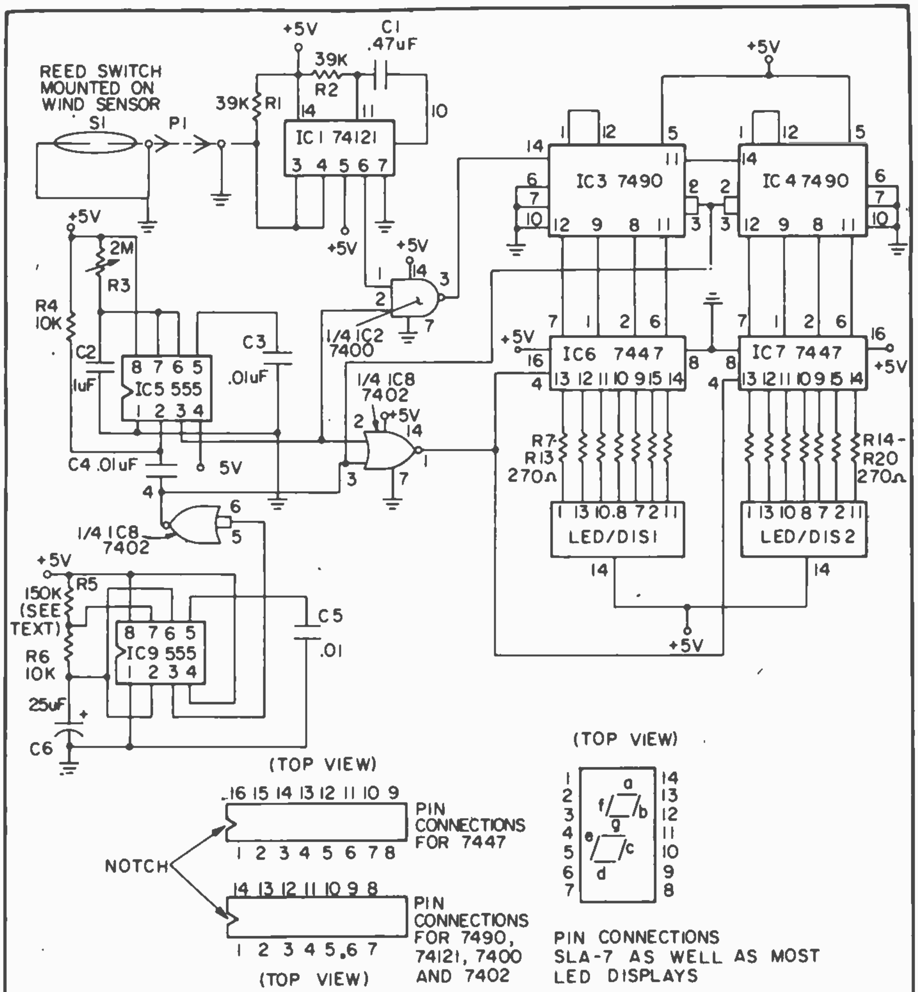


Fig. 7—Temporary battery power supply for use when calibrating the instrument in an automobile.



Be very careful when inserting ICs into their respective sockets. Be sure right types are inserted and oriented so that IC half-moon keys align correctly with sockets.

PARTS LIST FOR DIGITAL WINDSPEED METER

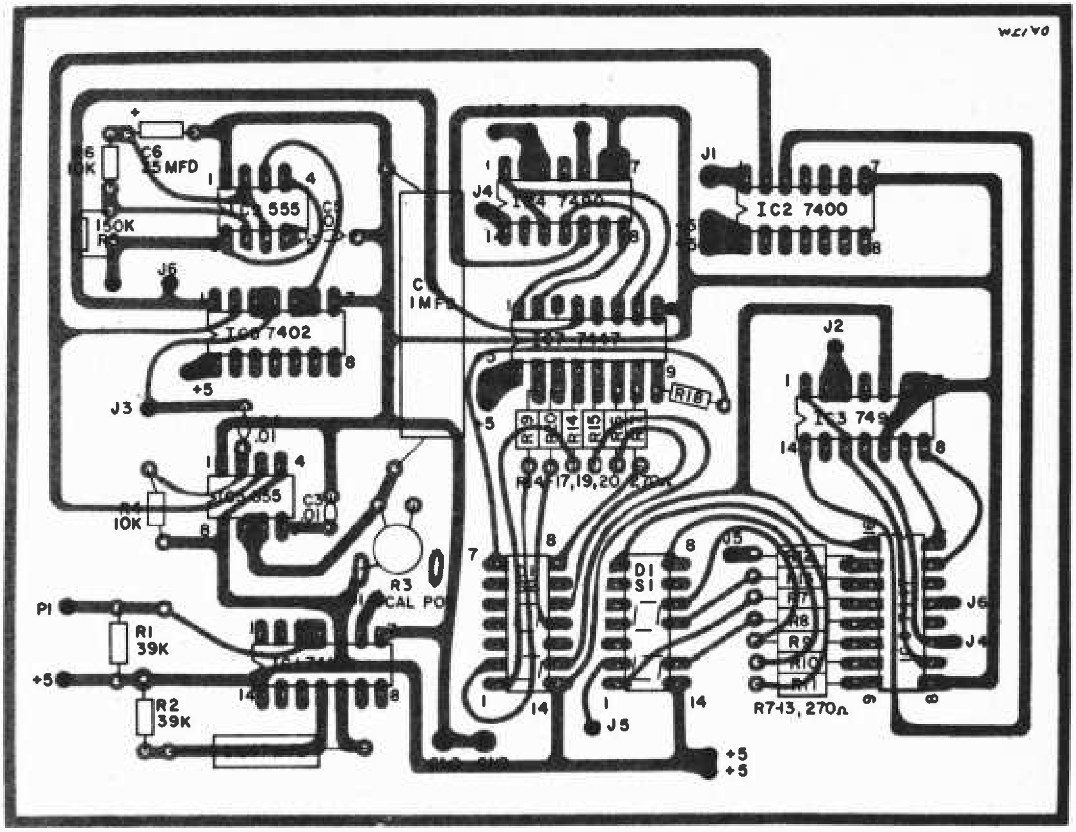
C1—0.47-uF, 50-VDC capacitor
C2—1.0-uF, 50-VDC capacitor
C3, C4, C5—0.01-uF, 50-VDC capacitor
C6—25-uF, 35-VDC or more electrolytic capacitor
LED1, LED2—LED display numerals (Radio Shack 276-053 or equiv.)
IC1—74121 monstable multivibrator integrated circuit, TTL type
IC2—7400 NAND gate integrated circuit, TTL type
IC3, IC4—7490 decade counter integrated circuit, TTL type
IC5, IC9—NE555 integrated circuit
IC6, IC7—7447 BCD-to-Decimal decoder, TTL type
IC8—7402 NOR gate, TTL type
P1—2-connector jack (& matching plug for cable) RCA-type phono plug recommended
R1, R2—39,000-ohm, ¼-watt resistor
R3—2-megohm printed circuit board-mounting potentiometer (Allied Radio 854-6287 or equiv.)
R4, R6—10,000-ohm, ¼-watt resistor
R5—150,000-ohm, ¼-watt resistor
R7—R20—270-ohm, ¼-watt resistor (14 needed)
S1—Miniature reed switch (Radio Shack 275-033 or equiv.)

Misc.—Four plastic cups such as the containers Leggs stockings come in. Two small magnets such as the "Magic" magnets most hardware stores carry. One 12-in. and two 6-in. pieces of copper or brass rod, ⅛- or 3/32-in. diameter (Brookstone, Peterborough, NH 03458 can supply two 12-in. 3/32-in. brass rods at 25 cents each, plus 70 cents for postage & handling). One slot car motor or equiv.), for use as bearing. One piece of copper or brass rod about 1-in. long, ½-in. diameter (solid). One 2-in. piece of wood two-by-four. Epoxy glue, solder, mounting brackets (two) for wood block, screws. Ten IC sockets.

PARTS LIST FOR TTL POWER SUPPLY

An ideal power supply for the Digital Wind Meter is the regulated power supply for TTL logic ICs described on page 48.

DIGITAL WINDSPEED METER



Pictorial shows the location of components as seen from the bottom (through the foil pattern) as they would be viewed in soldering to the foil. To get a full size foil pattern send a stamped, self-addressed envelope to: Electronics Hobbyist, Digital Windspeed Template, 229 Park Ave. South, New York, NY 10003.

cuit use any convenient layout on a perf board. The position of the components is not critical. If you haven't worked with ICs before you'll be better off soldering IC sockets in place on the perf board, and connecting the other components to the pins of the IC sockets. If you've had a fair amount of experience and can solder ICs directly into a circuit without overheating the pins (using a pair of long-nose pliers as a heat sink while soldering to each pin), do it that way.

The main job in wiring the anemometer lies in making the printed circuit board. The pattern shown can be made by using the simple resist method. Simply draw the pattern with a felt-tipped resist pen on the foil side of the printed circuit board, place in etching solution for an hour or so and drill the holes marked. The somewhat more sophisticated, yet still easy, non-camera photo method can also be used.

If a small 25-watt soldering iron is used, the *ICs* can be soldered directly to the board, although IC sockets are less risky. Be sure to orient the notch on the *ICs* as shown in the component layout diagram. It is always wise to use IC sockets when mounting display LEDs. Be sure to either bend back or cut off pin 12 on the socket which is used to mount Display No. 1.

Unless double sided PC boards are used, jumpers made up of hookup or bare wire are needed. Place jumpers between the two J1s, J2s, J3s, J4s, J5s and J6s. In addition, interconnect the +5 VDC points on the PC board with jumpers (6 needed).

Connect the two leads from the remote mounted reed switch to points P1 and to one of the two GNDs.

Connect the plus power supply lead to the +5 point at the top of the board. Connect the other supply lead to the other GND point which is also located at the top of the board.

The 5-volt regulated TTL power supply described by Herb Friedman in the Sept.-Oct. 1975 issue of ELEMENTARY ELECTRONICS is ideal for this project. This power supply is compact enough to easily fit in the same case as the logic unit.

The entire circuit can be mounted in any convenient size bakelite or aluminum case with aluminum panel. For a smart appearance, spray paint the panel with some auto-touch-up white lacquer. Use dry transfer decals for the lettering.

Cut a slot in the panel so the two digit LED display can be readily seen. If desired, the switch to turn on the power can be an inexpensive slide switch but a toggle switch is more reliable and easier to mount. The circuit board and all other components should be mounted to the back of the front panel for ease of accessibility.

If one desires a longer display time, increase R5 from the recommended 150k to 220k or even 270k.

Any type of two-conductor connecting jack can be mounted on the front panel (I used an RCA-type jack) as long as the appropriate plug is used. The two wire cable which connects the rotary wind sensor to the electrical unit must be long enough to reach from the roof to the place in your home where you want to keep the display unit. Any kind of shielded cable, including audio cable or microphone cable is OK. Coax such as RG-59/U is fine, but don't buy it special for this job because it costs much more than other (audio) cable.

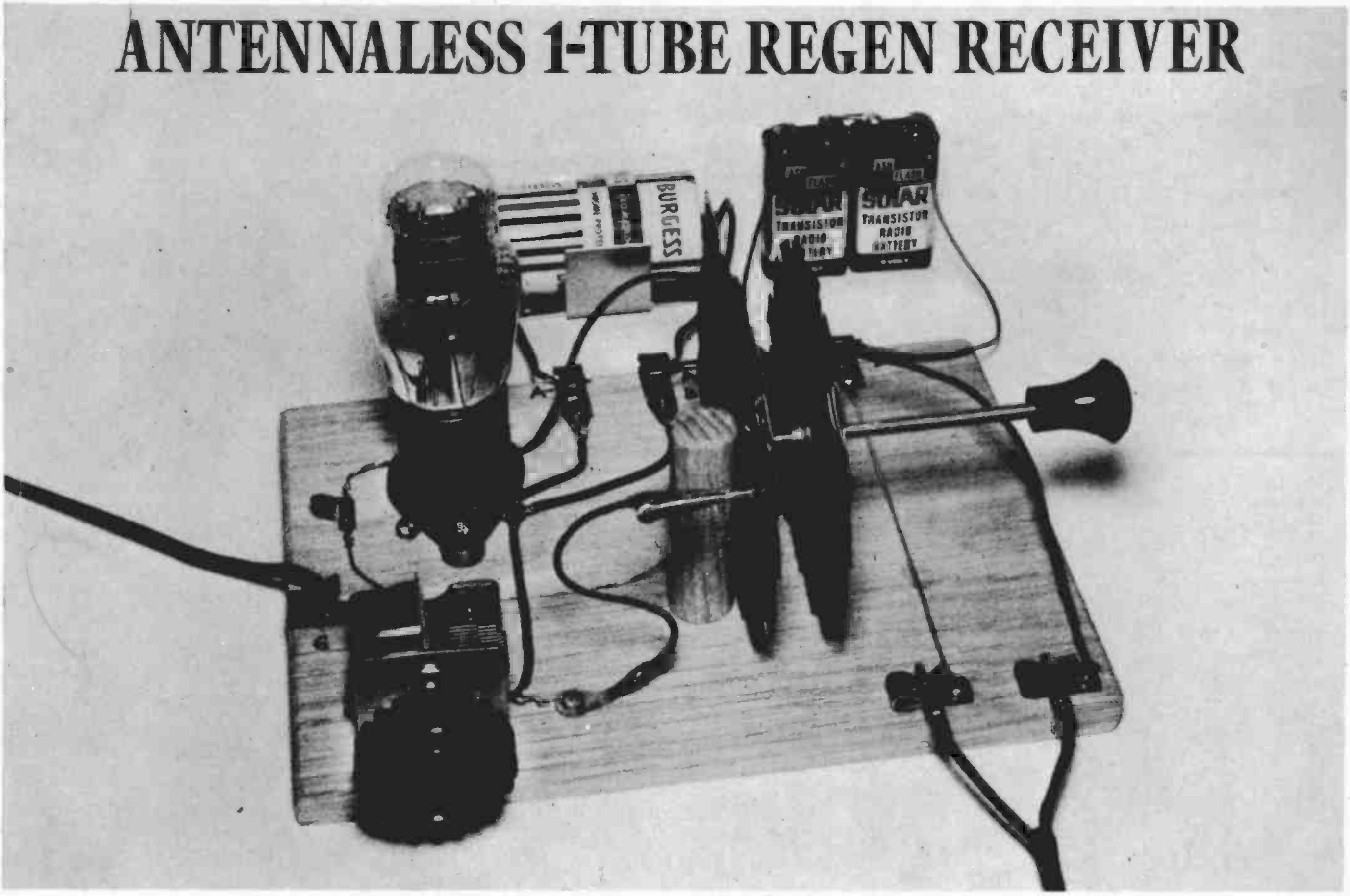
Calibration. This anemometer is easily calibrated since there is just one pot to adjust. As an initial test, plug the unit in and connect the wind sensor to the display unit. After a few seconds warmup the unit should show 00 then go momentarily blank. Turn the cups by hand and a number should appear on the display for a second or two and then disappear for a second. Now turn the cups as fast as you can by hand and adjust the calibration pot to read as close as possible to 20. If everything so far works OK, it is time to take the anemometer for a ride. If not, go back to Square One and check your wiring and the seating of the LED display modules.

The anemometer should be calibrated against an accurate automobile's speedometer. Since the anemometer will be away from the regular house supply, you will have to take along a 5-volt

(Continued on page 98)

Build an antique

ANTENNALESS 1-TUBE REGEN RECEIVER



This model-maker's delight actually works!

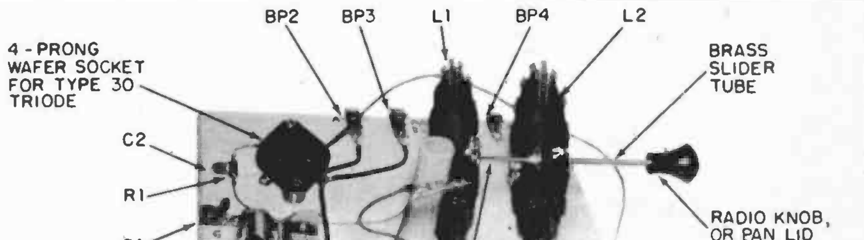
by Art Trauffer

A NUMBER of people would like to build a one-tube regenerative receiver, similar to the popular one-tubers of the early 1920s, but they hesitate, thinking that a long outdoor antenna is needed. So here's a novel receiver, resurrected from an item in Hugo Gernsback's RADIO NEWS magazine of the early 1920s, which requires no antenna and works well with only a connection to your water pipe! As a bonus, you will get less man-made and natural static!

This breadboarded regen receiver is beautiful in its simplicity, and you can probably find most of the parts in your "junk box." Coils L1 and L2 are the highly efficient "spiderweb" type of coils that were popular in the old days, and for capacitor C1 you could use the RF section of a gang capacitor salvaged from a junked AC-DC table radio. You can use any low-filament-voltage, low-filament-drain triode tube for V1. The writer used a type 30 in this project, since it has a filament drain of only .06 amps, making it easy on the "A" battery For a "B" battery, you need only two or three 9-volt transistor batteries connected in series.

Spiderweb Coils. The drawing of the coil form is an *actual size* pattern for making the two spiderweb coil orms. The writer used gray sheet fiber used for electrical insulation, but if you cannot obtain this use stiff cardboard and two coats of shellac.

Stationary coil L1 consists of 55 turns of #26 gauge enameled copper magnet wire, having three taps near the outside of the coil. In winding the spiderweb coils you start on the inside of the forms and wind to the outside. Punch two small holes in the form and anchor the end of the wire in these holes, allowing six inches of wire for connections later. Wind about 25 turns on the form; then twist a small loop in the wire for a tap;



All wired and ready to pull in those DX casts. Wiring is point-to-point, see schematic.

then wind 15 more turns and make another tap. The 55th turn (outside end of winding) will be tap number 3. Put a little Dupont Duco cement on the twist of each tap to make the taps rigid so you can scrape off the enamel on the taps for clip connections later on.

Spiderweb coil L2 is the feed-back coil, or "tickler coil" as it was sometimes called in the old days. L2 has about 50 turns of #26 wire, and no taps. Note that both coils should be wound and mounted so the turns of wire are in the same direction.

Putting It Together. Referring to photo of the regen radio, the hardwood baseboard (oak, walnut, maple, etc.) is 7½ in. by 5½ in. by ½ in. The supporting upright for the coil assembly is a 2½ in. length of ½ in., or ⅝ in. round or square wood dowel, screwfastened at the bottom using a 1 in. flathead wood screw and glue.

To make the adjustable assembly for the coils, use small diameter brass tubing (two telescoping lengths) obtainable at hobby and crafts supply stores. The author used ⅛ in. diameter tubing for the stationary support "rod," and mating tubing for the sliding "rod," but you may want to use larger, more rigid pieces. The stationary member is about 3½ in. long, and the sliding member is about 3 in. long.

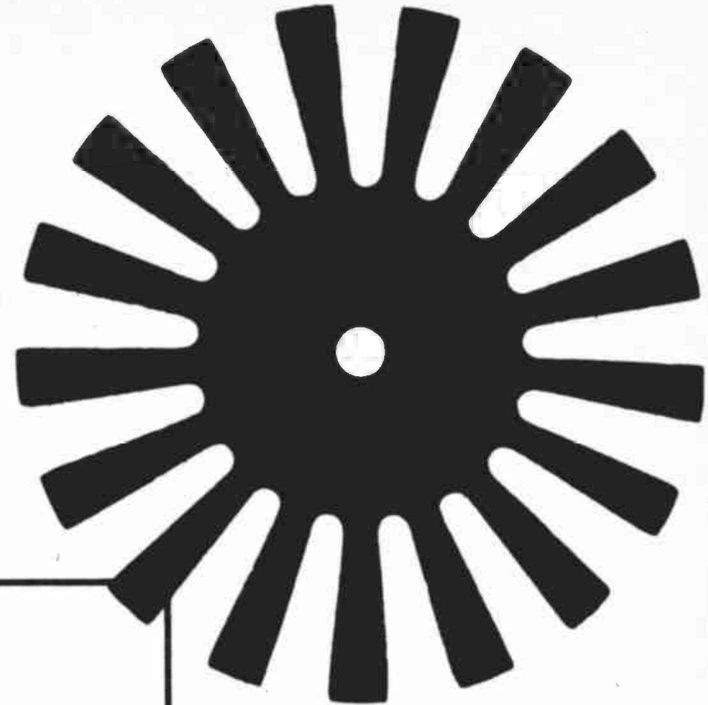
Drill holes of the required size through the center of coil L1 form, and through the wood upright dowel near the top. Pass the stationary brass rod through the hole in the coil form and into the hole in the dowel. Glue or Duco cement is used to hold coil L1 securely to the wood upright.

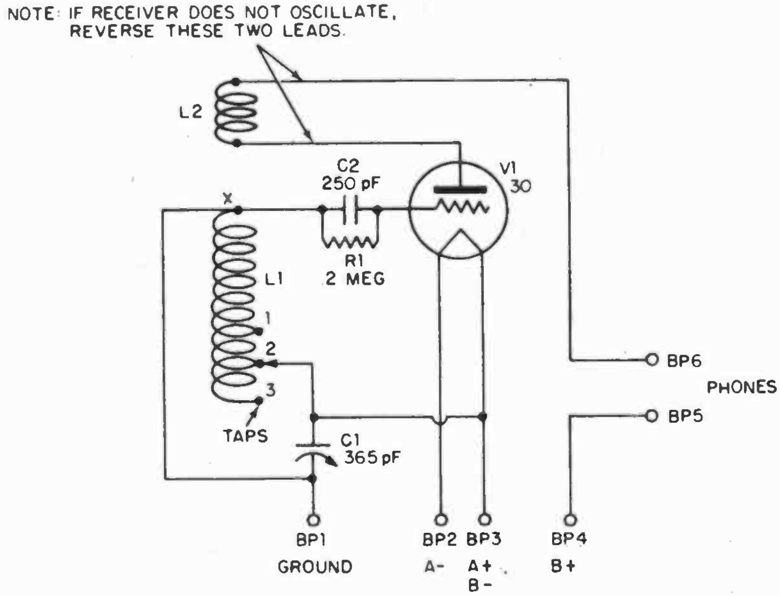
Drill a hole of required size through center of coil L2 form, and cement the coil form securely to one end of sliding brass tube. A knob goes on the other end of this brass tube.

The tube socket (type depending on tube used) is supported by two standoff metal collars, as shown.

The schematic diagram shows the simple hookup. Connections should be soldered wherever possible. Use a sensitive pair of high-impedance magnetic earphones when listening. A size D flashlight cell will last for a while with a type 30 tube, but a No. 6 ignition battery will last longer. No switch is used—simply disconnect the "A" battery! For the "B" battery, connect two or three 9 volt transistor batteries, in series. ■

Spiderweb coil form shown at right is same-size pattern. Use it to make another. You'll need two.





PARTS LIST FOR ANTENNALESS 1-TUBE REGEN RECEIVER

C1—365-pF. variable capacitor
C2—250 or 220-pF. (.00025 uF) ceramic disc capacitor
R1—2-megohm, ½-watt resistor.
V1—any low filament voltage, low filament drain, triode vacuum tube (Author used type 30)
1—baseboard-mounting socket for vacuum tube (V1)
BP1-BP6—medium-size Fahnestock clips
L1—home-made spiderweb coil, with three taps (see text)
L2—home-made spiderweb feed-back ("tickler") coil (see text)
1—#26 gauge enameled magnet wire for L1 and L2
1—4-in. by 8-in. piece gray sheet fiber, for making coil forms (see text)
1—wood baseboard, 7½-in. by 5½-in. by ½-in. hardwood
1—round or square ½-in. wood dowel, 2½-in. long (holds spiderweb coil assembly)
2—round or square telescoping brass tubing, for spiderweb coil slider (see text).
Misc.—hardware: Knob for C1. Mounting screws for C1. Mounting screws for Fahnestock clips. Soldering lugs. Mounting screws and stand-off collars for tube socket. Hookup wire. Flexible wire for "tickler" coil (L2) pigtail leads. Small alligator clip. Pair high-impedance magnetic earphones. "A" battery for V1. "B" battery for V1. Two or three 9-volt transistor batteries connected in series. (see Antennaless text).

For type 30 tubes, try the following sources: Mr. George Haymans, WA4NED, Box 468, Gainesville, Georgia 30501.
Modern Radio Labs., P.O. Box 1477, or 10322 Ballard Drive, Garden Grove, California 92642.
Or any of the other surplus tube mail-order firms that advertise in radio and electronics magazines.
Other low filament voltage, low drain, triode tubes: 1H4-G, 1G4-GT, VT-24/864, 1B5/25S, 1H5-GT, 1LE3, 1LH4.

What are your opportunities in the electronics field? Here are some eye opening facts from ETI.

Q. What about the job market in electronics?

A. It's good. In fact, it seems to be one of the few fields that stays relatively steady in bad times. Today, for example, estimates indicate that several thousand jobs will be opening up for electronics technicians each year, for years to come. One reason for this is the fact that electronics are the basis of almost all communications, and this is a communications-oriented nation.

Q. What kind of jobs are you talking about?

A. For example, there are jobs available in electronic/industrial automation, electronic equipment repair and servicing, in the broadcast and radio telephone communications field, at airports, and even in medicine and in hospitals, where electronics are rapidly increasing in importance. And there are hundreds of other jobs opening up as electronics continues to make great strides, in new ideas and developments.

Q. Can such a complicated subject as electronics be successfully taught by the home-study method?

A. Of course it can. Electronics Technical Institute has proven that beyond a shadow of a doubt. Our graduates are working in practically every phase of electronics. This is largely due to the kind of instruction provided by ETI. For example, its course in the Fundamentals of Electronics features an exclusive teaching system called Autotext. And throughout all the courses the student is thoroughly monitored and carefully guided by a licensed instructor, whose professional and personal interest is to see that he masters every bit of information presented to him. Of course, we must give a lot of credit to our students themselves. They know that no matter how good the instructor and instruction may be, *they* have to make it work. So most of them apply themselves diligently, and they find the more they learn, the more they *want* to learn.

Q. But I have a job, and as much as I would like to get into electronics, I can't afford to take time off. How do I get around that?

A. You don't have to take time off from your job. You study at home, in your free time. We do advise, however, that you set aside a certain time for your study schedule and stick to it, even if it's only a couple of hours a day. The beauty of the ETI way of learning is that you work at your own pace, making sure you've completed your assignment thoroughly and completely. We think you'll find, as you go along, that learning the ETI way can be fun.

Q. But I was never very big on books and study. I like to work with my hands.

A. With your ETI course, you'll get plenty of work with your hands. In fact, the

ETI system of teaching combines hands-on work with study, so that you actually learn by doing. As you move along developing your technical knowledge, you will use, in many phases, specially developed Project Kits. So you apply your knowledge in logical, hands-on sequences, from the first step through completion of basic units. It all adds up to knowledge and self-confidence gained by actually *doing* the job.

Q. It all sounds very interesting and inviting. But I wouldn't want to commit myself before knowing more.

A. We wouldn't want you to. In fact, we insist that you check it out first. All you do is fill out the card or coupon and mail it to us. We'll send you a colorful new 48-page ETI Career Book that will give you the facts and the many opportunities ETI can open up for you. If you like electronics, you'll enjoy reading this book.

Q. Do I obligate myself in any way by sending for your book?

A. Absolutely not. The ETI Career Book is free, and it involves no responsibility on your part, nor will a salesman call on you. All we want to do is to be sure you have all the facts about ETI and what it can mean to your future. And you can get these facts and complete information about ETI's 18 different courses and programs in electronics by filling out and mailing the coupon to us today. We'll send you ETI's Career Book by return mail. We think it will be a real eye opener for you. Mail the card or coupon today.

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PUTTING HI-FI IN

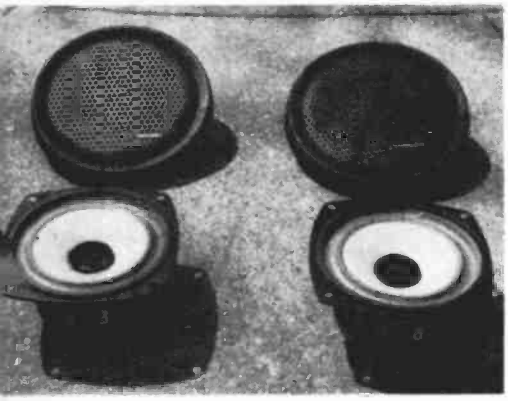


Fig. 1. The basic rear speaker package has the speakers and matching protective grill assemblies. Note the large outer surround on the speaker cones; a pretty reliable guide that these relatively small Radio Shack speakers pack a lot of solid bass.

BESIDES THE OBVIOUS luxury of carpeted floors, leather seats, and leg room for a giant, big fat luxury cars generally have much better sounding radios and tape players. Quite often the luxury car's sound quality begins to approach or equal what we'd accept as hi-fi in our home.

But the secret to a luxury car's better sound is not necessarily that the radio or tape player is any better than what's put into a budget car; rather, the gold-plated Detroit Iron probably has rear deck speakers, and that's what gives it that big sound.

When speakers are mounted on the rear deck the entire trunk becomes a speaker enclosure, and it is a fundamental rule of automobile sound that the larger the enclosure the better the bass. Also, with the speakers facing upwards the highs bounce off the slanting rear windows towards the passengers; the reflection also disperses the highs, creating a "surround-sound" that envelops the passengers in a total experience—as if they were one of the musicians.

Yes, rear deck speakers make any auto radio or tape player sound better, but there's no reason you have to wait for a luxury car in order to enjoy a big, rich sound. We don't know about those cheap foreign imports where everything but the four wheels and a body is left off to keep the price down, but American-made cars are factory-equipped for rear speakers. In most cases a piece of cardboard is all that separates you from rear speakers. You see, here in the U.S. the manufacturer can't be bothered

with making one model for the guy who wants rear speakers and a different model for the buyer who doesn't even want a radio. So he makes one basic metal rear deck pre-cut for speakers. If you order the car wihout speakers the assembly plant covers the metal rear deck with cardboard, hardboard, or fabric, concealing the speaker cutouts. If you order speakers factory installed, the assembly plant simply substitutes a cover that also has speaker cutouts, and installs the speakers. If you get the car without speakers and then decide you want rear speakers the dealer hands a knife to the least skilled man in the shop and tells him to cut out the cover and install the speakers.

To make life just a little bit easier for everyone, many cars are already pre-wired for rear deck speakers even if they haven't been installed at the assembly plant. Again, it's often easier for Detroit car makers to stock one general

Fig. 2. You might have to jackknife yourself into the trunk to make a few connections so make certain the trunk is completely empty before you start. Yes, get rid of the spare tire too.

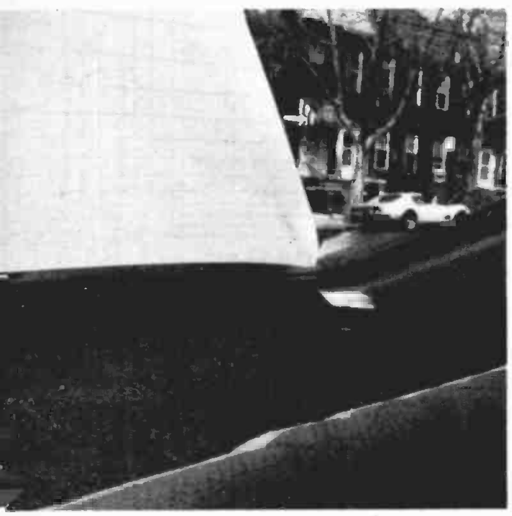


Fig. 3. The rear deck. Concealed beneath that layer of carpeting is a steel deck with the speaker cutouts already prepared at the factory. Even the speaker mounting studs might already be installed.

Fig. 4. Just one speck of dust in the cone from installation will rattle for ever and ever. But if you wrap the speaker in an old pantyhose (or even new pantyhose of the 2-for-a-$1 variety) you'll be able to keep chips out during installation, and the heavier dust—which also rattles—that settles in after the speakers are installed. Leave enough slack in the material so it can be completely wrapped around the speaker when you're finished.

Fig. 5. If you cut and wrap the pantyhose carefully it should look like a factory installation.

THE REAR DECK

purpose wiring harness than several different models. Often, the rear speaker wiring is tucked into a rear quarter panel along with some extra wires for a rear window defogger, trunk lamp, etc. If you have been wise enough to get your car's service manual you'll be able to locate concealed wires by using the schematic and wiring pictorials supplied in the manual's electrical and accessory sections. Even if your car isn't prewired, the manual will tell you where the front-to-rear wiring channel is located. If you know where the channel is located you can run a wire from the trunk to the dashboard in less than 15 minutes. If you don't know where the channel is located, or even if there is one (and there is), you can spend an hour or more trying to get a pair of speaker wires from trunk to dash.

As for the speakers themselves, get the best; the difference in price between good-quality speakers and poor ones is only a few dollars. It won't be worth your time and effort if you save a couple of bucks only to wind up with fourth-rate sound quality.

The best place to find high-quality auto speakers is a local general parts distributor (not an auto-sound specialty shop), or one of the national chains; for it is in these places that you'll get a chance to listen to the actual speaker you'll buy, or at least have easy return privileges if you decide you want a better-quality speaker.

The rear deck speaker kits shown in this article came from Radio Shack. You'll note that although the speakers are small they have a relatively large magnet and an obvious large and soft cone surround. This is the stuff of big bass, even in small speakers, and is the payoff when you've completed the installation. Your only problem is to check the size of the cutouts in the rear deck first, and then get the speakers that match. For example, you might have 5-inch round cut outs, or 4 x 5-inch or 5 x 7-inch oval. Get the right size. Don't try to use a 4 x 5 in a 5 x 7 cutout. Part of the sound quality is determined by the fit of the speaker against the rear deck, so match the speaker to the cutout. Finally, get a complete mounting kit: It will save problems later when you try to match a protective grille to a speaker bought earlier; somehow, it usually doesn't come out right because the holes don't match when you buy one piece here, another piece there.

Okay. Ready? Just follow the photographic illustrations to terrific sound. ■

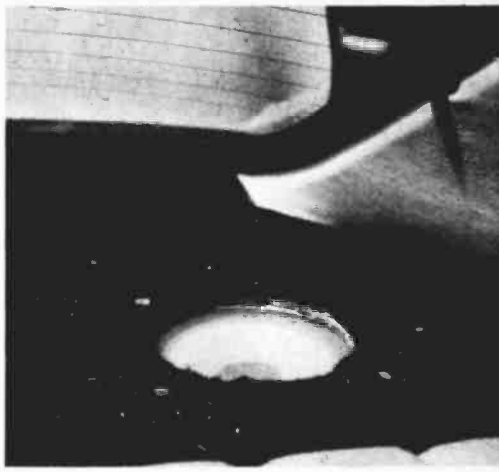


Fig. 10. View from the top. Brush all debris and chips off the pantyhose shield.

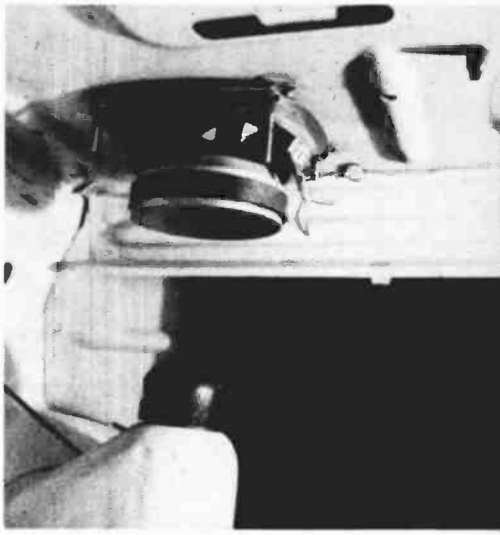


Fig. 9. Connect the speaker wires and route the wires so they are off the floor where they cannot be damaged.

Fig. 6. Cut a hole in the rear deck cover corresponding to the cutout in the steel deck underneath.

Fig. 7. Here's how it looks from inside the trunk. Note that in this car even the speaker mounting holes are pre-punched. Just drill through the rear deck cover from the trunk side. The metal tabs at the rear hold the speaker wires when they are bent upwards.

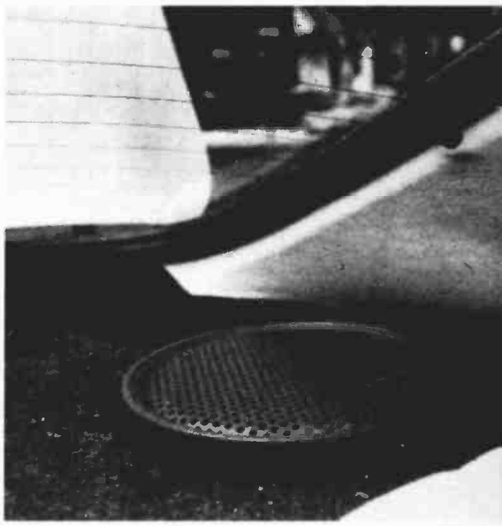


Fig. 8. Install the mounting screws—held in place with Tinnerman nuts, or tape—and then carefully fit the speaker over the screws. Snap down the grill and the installation is complete. A neat, professional job that looks like it came straight off the assembly line.

BUILD A PROFESSIONAL DWELL/TACH

Stretch more miles from your gas supply, plus tune-up tips!

by C. R. Lewart

WITH GASOLINE prices going up, and with the growing concern about air pollution caused by automobile exhaust, a well-tuned car becomes a must. One of the essential tools for a tune-up is a dwell/tachometer that helps you adjust your engine to its optimum specs. What we describe here is a dwell/tach based on a newly-developed integrated circuit. It's easy and inexpensive to build, but with the IC it will also be more precise and easier to handle than most currently available commercial units. You may either put the unit in a portable case, as we have done, for use as a diagnostic tool, or you may mount it permanently on the dashboard.

The main advantages of the circuit are readings basically independent of the battery voltage, temperature, and the shape of the voltage at the points.

How Does It Work? First let's consider the shape of the voltage at the distributor points. When the points open there is a sharp spike of 100 to 300 volts followed by damped oscillation settling at the battery voltage as shown in the illustration. When the contacts close, ground is applied to the bottom of the ignition coil, and voltage across the points drops to zero as current flows in the ignition coil primary.

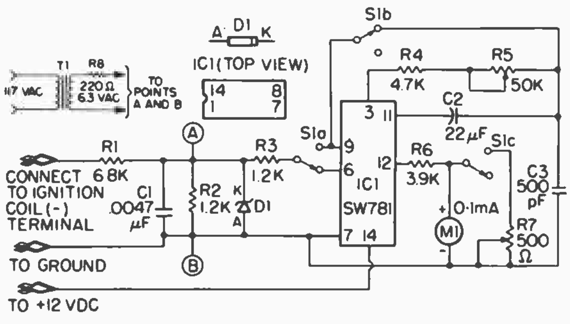
In the integrated circuit there is a temperature-compensated monostable pulse generator section, an amplifier-limiter section, and a voltage regulator section.

For the tachometer mode, the input circuit (R1, R2, R3, D1 and C1) assures that only the initial high-voltage spike caused by the opening points triggers the pulse generator. The generator produces a single rectangular pulse whose amplitude is determined by the IC parameters, and whose pulse width is determined by R4, R5, and C2. The pulses are amplified and fed into a one-milliampere meter which reads the average current. The higher the RPM, the more pulses, and the higher the meter reading.

In the dwell meter mode we bypass the pulse-generator section of the IC and apply the signal directly to the amplifier-limiter section. The meter reading then corresponds directly to the percentage of time the points are closed.

Calibration. The easiest way to initially adjust your unit is to connect it to a 12-volt battery and use a small 6.3-volt filament transformer to supply 60 pulses per second from the power line. *A 60-Hz line frequency corresponds to the following meter reading in rpm.* Set meter to the proper reading with calibration control R5. A 4-cyclinder engine scale would read *1800 rpm* with the 60-Hz input, a 6-cylinder engine would read *1200 rpm*, and an 8-cylinder engine, *900 rpm*.

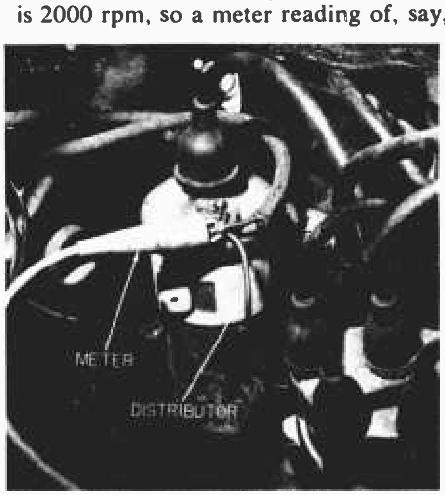
If, for example, you decide on a 2000-rpm full scale for a 6-cylinder engine (equivalent to 3000 rpm for a "4-banger" and 1500 for a V-8), set calibration control R5 for a 0.6 mA reading. The calibration reference for a 6-cylinder engine in rpm (1200) divided by the full scale in rpm (2000) times the full scale meter reading (1 mA) equals the calibration point meter reading in current (0.6 mA). Once calibrated, the rpm value is determined by multiplying the meter reading and the full scale. In this example the full scale is 2000 rpm, so a meter reading of, say,



PARTS LIST FOR DWELL/TACH—A GASOLINE ECONOMIZER

C1—0.005-uF capacitor
C2—0.22-uFcapacitor
C3—470-pF capacitor
D1—Zener diode, 9-volt, ½-watt
IC1—SW781 (available directly from the manufacturer, Stewart Warner Corp., 730 E. Evelyn Ave., Sunnyvale CA 94086, for $5.25 postpaid)
M1—0-1 mA meter
R1—6200-ohm, 1-watt resistor (you can use two 12,000-ohm, ½-watt resistors in parallel)
R2, R3—1200-ohm, ½-watt resistor
R4—4700-ohm, ½-watt resistor
R5—50,000-ohm potentiometer
R6—3900-ohm, ½-watt resistor
R7—500-ohm potentiometer
R8—220-ohm, ½-watt resistor
S1—4PDT switch, 3 sections used
T1—Transformer. 117 VAC to 6.3 VAC

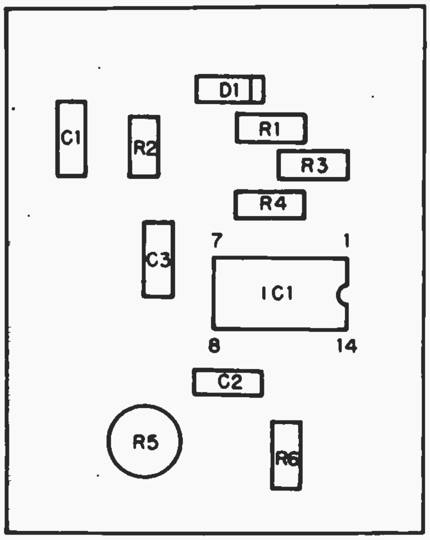
Misc.—Cabinet, perf board, clip leads, wire, solder, etc.



Clip "meter" wire from dwell/tach to ignition coil minus terminal. Look for "distributor" wire. It runs from the (—) terminal to the base of your distributor.

0.4 mA would mean an engine rpm of 800. Once R5 is set it should not require recalibration unless accidentally moved. If you prefer several ranges on a tachometer, or if you would like to use the same scale for 6- and 8-cylinder engines, switch-select a second pot of the same value as R5. Use one switch setting to calibrate for 6-cylinder engines, then throw the switch and use the second pot to calibrate for 8-cylinder engines.

It might be a good idea to tape a small mA-to-rpm conversion chart to the back of your meter. Compute rpm values for major meter divisions to give



Use perfboard construction and lay out circuit components as shown. R7, S1, and M1 are located on front panel.

yourself a quick conversion capability, particularly if you choose a full scale of other than 1000 rpm. If you select a 1000-rpm full scale for V-8 engines, the meter will read directly in rpm. Just ignore the decimal point. For example, .55 would be 550 rpm.

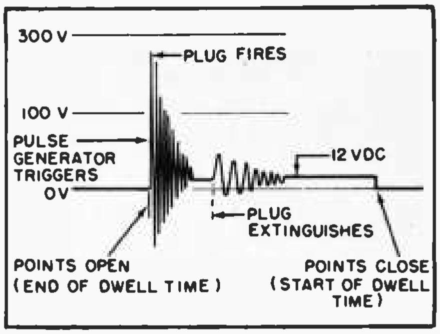
With the values of components shown, you can adjust R5 for a full scale reading for a 6-cylinder engine between approximately 1200 and 6000 rpm.

A dwell meter adjustment is done with R7. When the input (points) lead is disconnected, the meter should read full scale. Due to excellent voltage regulation in the IC, this potentiometer should not need adjustment after your initial setting. Full scale automatically corresponds to a 45-degree angle for an 8-cylinder engine, 60 degrees for a 6-cylinder, and 90 degrees for a 4.

Operation. Connect plus and minus power input leads to your 12-volt car battery. Switch S1 to the dwell function and adjust if necessary for a full scale meter reading, then connect the third lead to the points (thin wire going from coil minus to the distributor housing). Now you are ready to take measurements.

Auto Ignition Info. Let's define some of the points about ignition points. A term used very widely is distributor contact dwell. Degrees of distributor dwell are the degrees of rotation during which the breaker, or contact points, remain closed. This is commonly referred to as dwell angle or cam angle. Correct distributor contact dwell is essential for good ignition performance and point life. Distributor contact dwell in effect is the amount of time that the points remain closed. During this interval of time, magnetic energy builds up in the ignition coil, which, when the points open, generates the high voltage pulse that *arcs* across the spark plug electrode. Generally a longer dwell period (larger dwell angle) is more advantageous for high speed operations.

Replacing ignition points is a simple matter of unscrewing the point retaining plate and screwing down the new one. This is just the beginning of a good tune-up. To check dwell reading you should have a dwell meter. Like most, ours is combined with a tachometer. With the engine running and the dwell meter/tachometer connected you should observe the dwell meter reading. If the dwell reading is within specifications for the engine then you can assume you have the correct gap, and that point contacts are in satisfactory condition. If the



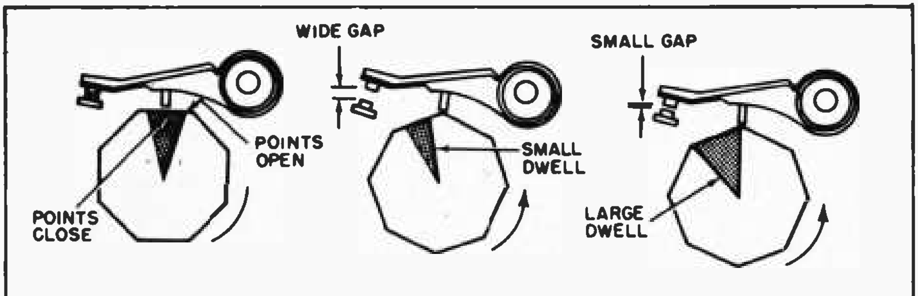
A pulse generator in your dwell/tach is designed to trigger just once each time the points open and a plug fires. Erratic behavior in some non-electronic tachometers is due to this complex wave.

dwell reading is not within specifications, the point gap may be incorrect, the cam worn, the rubbing block worn or the moveable contact arm may be distorted.

Mini Lube Job. Distributor lubrication is something which is usually overdone. If the distributor has an oiler on the outside of the distributor base, add three or four drops of SAE10W motor oil to the oiler. If there is a felt wick under the rotor at the top of the distributor cam, use three to six drops of SAE10W oil. All grease should be wiped from the distributor cam and rubbing block. It's very important that the ignition points be free of grease or oil.

Many ignition systems use dual breaker points. These dual breaker point systems are designed for long life and good high speed performance. They are handled in the same way as single ignition points with the following exceptions: One set of contacts should be blocked open with a clean insulator. A matchbook section makes a good clean insulator for this. Adjust the opposite set of points to specifications using a dwell meter. Loosen the stationary contact block screw just enough so that the stationary contact can be moved with a light touch, otherwise it will be difficult to set the contacts accurately. When the one set of contacts has been adjusted for the correct clearance, tighten the stationary contact lock screw. Block the adjusted set of contacts with an insulator and adjust the other set of contacts in the same manner as the first set. Remove the insulator and recheck the tightness of the stationary contact lock screw. If the contacts have been properly adjusted the dwell should be as specified for both contact sets. Again you must make sure that the gap and the dwell specifications are met for both sets of points.

Don't Overlook The Carb. A list of malfunctions caused by a sick carburetor reads like a "Who's Who of Auto



As a gasoline engine runs, a normally closed switch called the "points" is constantly being pushed open by a cam. Whenever the points open, a high voltage is generated by the ignition coil to "fire" a spark plug. Dwell shows how many degrees the cam turns before it opens the points.

Ailments." It includes hard starting, flooding, delayed acceleration, poor gas mileage, stalling, rough running, fouled spark plugs, and the gas leaks at the carburetor.

Not all of these problems, however, result only from an ailing carburetor. For this reason you should make sure spark plugs, ignition parts, compression, and timing are all in good condition before beginning carburetor service. In short, make sure your engine is correctly tuned, because your carb depends on the proper operation of the rest of the engine.

All types of carbs—no matter how many barrels—have only one throttle adjusting screw. Two- and four-barrel units, however, have two idle adjustment screws—one for each idle system.

Warm the engine to operating temperature and have the choke valve completely open when adjusting. Start the engine and let it idle. If it stalls, turn the throttle screw in until the engine is running steady without any foot pressure on the accelerator.

The idle mixture should be adjusted to give a smooth idle. Missing is a sign of too lean an idle mixture, while rolling or loping indicates too rich a mixture. Turning the screw in leans the mixture. It may be necessary to readjust the idle speed and mixture after the air cleaner is installed.

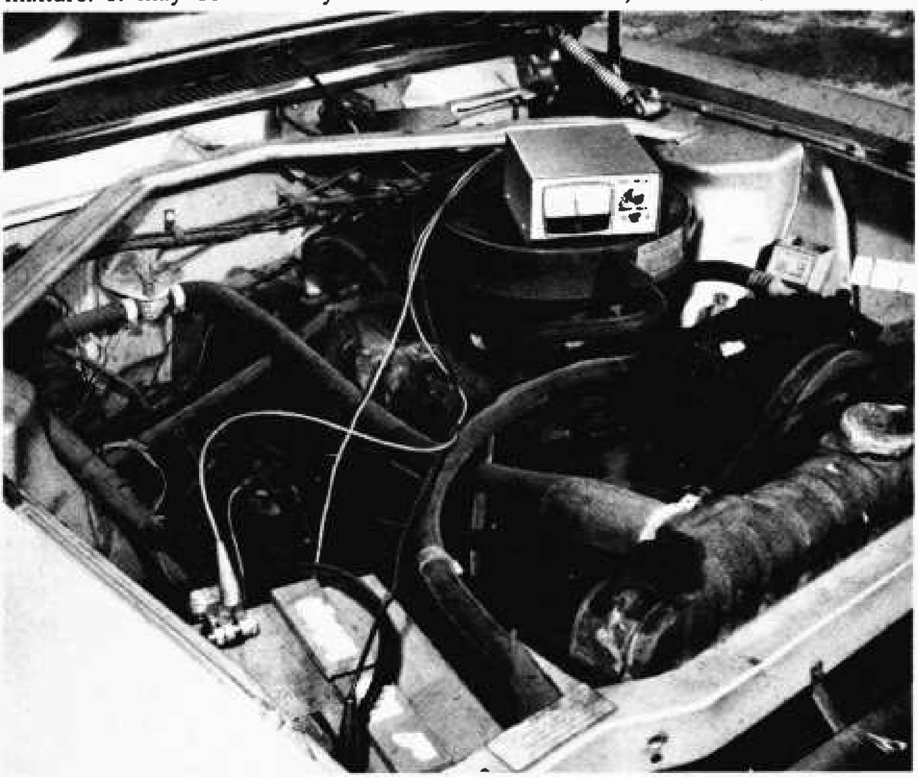
(Note: late model smog-controlled cars usually have a plastic limiter that restricts the movement of the mixture screw. An acceptable mixture of adjustment should be possible within its limits.)

Turn the idle adjusting screw in slowly until the engine is about to stall. At this point, turn it out about a half-turn. If the engine seems to race, turn the throttle adjusting screw out slowly until the speed comes down.

Service Your Plugs. Be extremely careful how you apply the socket wrench over the spark plug insulators. While they can resist the sledge-hammer blows under extreme temperatures and load that take place inside the cylinder each time they fire, they can be cracked by carelessly banging them with a wrench either taking them out or putting them in.

After removing your spark plugs, you have three things you can do: put them right back in the engine, have them cleaned and regapped and reinstalled, or replace them with new spark plugs.

In the first case, you may merely want to examine the general condition of the plugs or check to see if the heat range is correct for the particular engine. Choice number two would be normal if spark plugs have only been used for around 5,000 miles and show normal wear. Clean and regap after 5,000 miles of use. Choice three would normally apply to spark plugs that have 10,000 miles of use or more on them.



Tune-up helped this overdrive equipped '68 Rambler increase mileage from 21 to over 25 mpg at today's 50-mph speeds. They laughed when I ordered overdrive back in 1968. Now one tank gives us a 375-mile driving range!

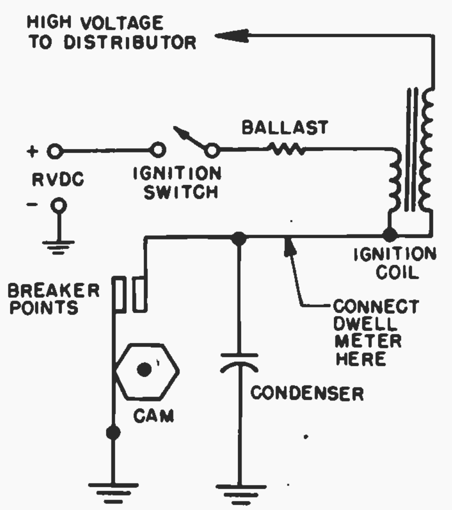
Assuming that no particular complications exist, soak the spark plugs in a good parts cleaner for a few minutes to remove any oily deposits that exist.

To remove carbon deposits, use a small knife or any other small tool which will fit up inside the plug along the insulator. Be careful not to chip the ceramic and avoid the use of a wire wheel, which will completely ruin the plug.

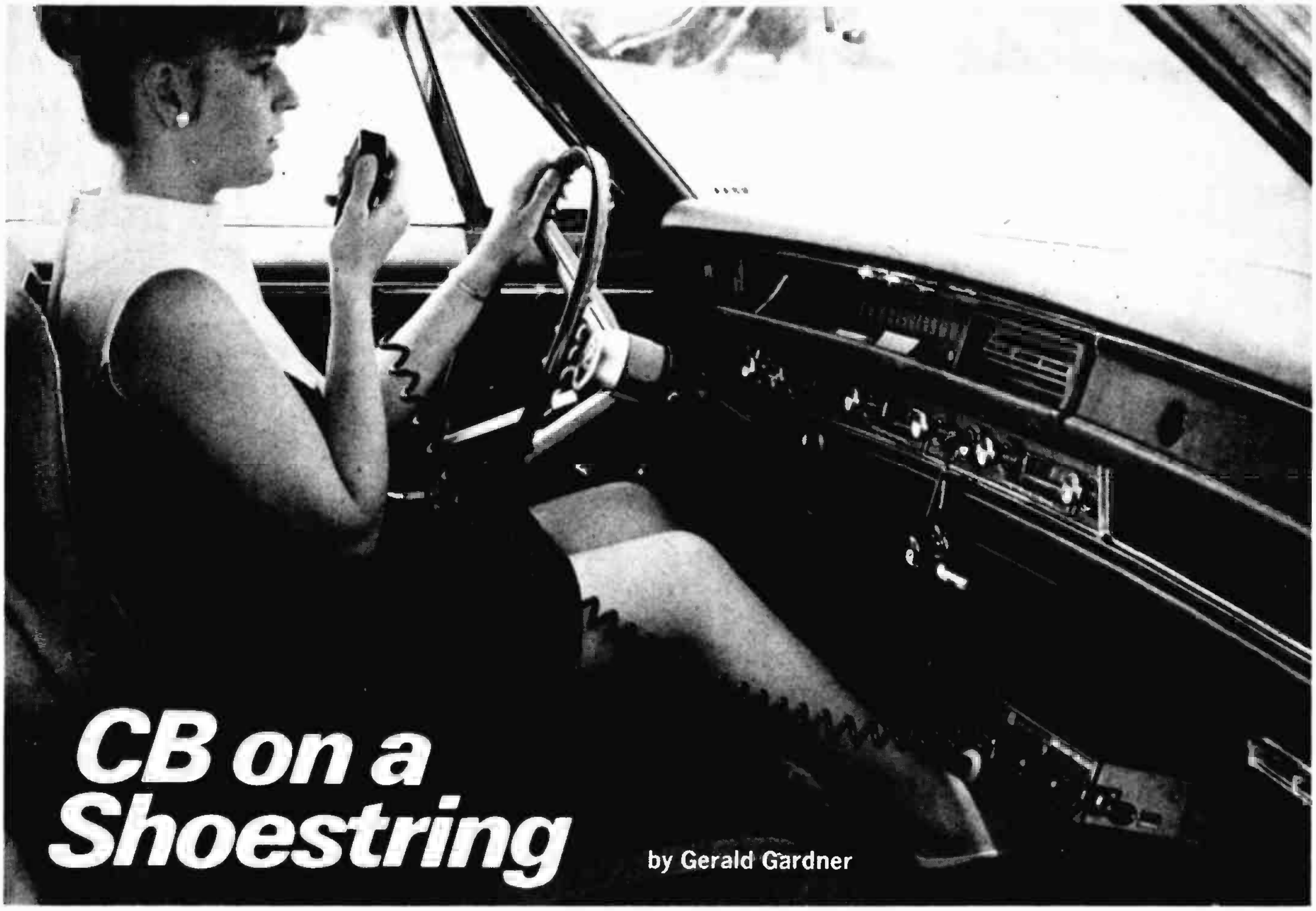
Hard carbon formations are often impossible to remove. As you examine the plugs, you may notice such a condition, or possibly a burned condition of the electrodes. In such a case, it's advisable to install a new set of spark plugs as you'll need them soon anyway.

If the condition of the spark plugs is satisfactory after cleaning, open the gap. File the electrode sparking surface with an ignition point file before opening up the gap. You will get better firing from clean, flat surfaces, so this is an important part of spark plug servicing. Finally, adjust the gap to the manufacturer's specifications (Check the owners manual).

Making sure you have the right spark plugs installed and that they are in good condition is vital to good ignition system performance. But it's only part of the story. Other parts of the system must be working properly if the plugs are to do their job. Wiring, distributor components, and coil condition all affect the production of a healthy spark. ■



This is a typical non-electronic ignition system used for nearly all auto and truck engines since Henry Ford dropped buzzer ignition for his Model A. Additional part of ignition switch usually shorts out the ballast for more spark during starting.



CB on a Shoestring

by Gerald Gardner

BACK IN THE pioneer days of Citizens Band (CB) radio there was only one basic type of transceiver—it turned on and off, the volume could be adjusted, it had a squelch, and more often than not it operated on one, two, or three channels. Color it cheap.

Of course, those were the days when CB operators were as scarce as Eskimos in Ecuador; nobody knew about fancy refinements, state-of-the-art, and that sort of thing. The majority of CB manufacturers were hand-constructing a few dozen CB rigs per week to meet their needs.

I suppose that by now you've heard that the awkward child has grown up; CB radio has turned into the darling of the public, a 9-headed monster for the FCC, and one of the few industries which is still smiling (and often back-ordered) through the current industrial/economic "situation."

And, as you might have imagined, the equipment design, styling, refinements, and *prices* have come a long way up the pike since the old days. Specialized CB rigs are available for installation in cars, trucks, boats, and even motorcycles! To add spice to the market, CB rigs with all sorts of exotic technical gizmos and developments now confront the CB shopper, things such as single-sideband (SSB), crystal synthesis, power-boosted modulation, all channel operation, speech clipping, remote control, telephone handsets, tone alert, integrated circuits, light emitting diodes, receive preamplification, variable sensitivity, public-address systems, tone control, VOX, mechanical and ceramic filters, noise blankers, digital alarm clocks, desk mikes, fully metered functions, dual base/mobile power supplies, and lots of designer styling. Naturally, as hoped for by the manufacturers, sets containing combinations of these features are sensational sellers in the CB marketplace—some tipping the scales at the $600 price mark!

Why the Rip-Off? What's happened is that, somewhere in the backwash and dust of all this clamor, the poor soul who just wants to get on the air, no strain, no pain, has gotten the impression that unless he can unload about $1300 on a base station (and there's still that mobile installation to think of too!), there is hardly any point in trying to get involved in CB radio, for certainly any installation which doesn't include a $600 rig, a monster $350 directional beam and rotor perched atop a 50-foot $175 to $350 transmission tower and fed with 20¢-per-foot super-low-loss coaxial cable, will not put even a feeble signal across the neighborhood. *Not so!*

Back in the past, CBers forgot their humble roots, that they could operate quite effectively for most local communications purposes with a rather miniscule investment. Today's CBers have forgotten that while all of the chrome and frills are spiffy to have (if you have the cash to invest), these extras are far from being absolutely necessary in order to fulfill CB's basis premise, that of being able to get a message from here to somewhere else.

Yes, in the midst of the glitter and dazzle of space-age exotic technology, the consumer has managed to *disremember* that beneath the facade of knobs, meters, gadgets, and chrome of even the most spectacular deluxe CB rig there lurks (in one form or another, and by whatever fancy technical terms it may be described) a 5-watt transmitter and a 27-MHz receiver; and these same two components were part of a CB rig 15 years ago, and they are still part of even the most inexpensive CB gear today!

And while you can put as much as $350 into a great-looking tower, you can still get your message from here to

Royce 1-590 3-channel mobile full-power transceiver is a bargain hunter's dream. Slide volume control and mini-packaging are indicative of quality guts inside.

there without one—or with something a lot less costly which will accomplish the same purposes. You can, if you wish, spend $350 on an antenna and rotor, but you can also send your signal out in all directions for about 5 percent of this cost.

And you can also get your signal to travel to the antenna without the deluxe accommodations of coax costing 20¢ per foot.

Many Just Don't Know. The fact of the matter is that CB is a consumer market, and the average CB consumer is not sufficiently hip to the ins and outs of CB radio in order to avoid overbuying, even without any coaxing from a high-pressure salesman. If a $3000 Chevy is good, a $6000 Buick is twice as good, right? So if a $1300 CB installation is great, a $650 installation is fair, and a $325 installation is a joke, right? Wrong!

Inexpensive CB gear is still being produced, quietly and with far less hullabaloo than the stuff with the fancy trimmings. Let's see how a fully operational and effective CB station might be assembled on a shoestring. Let's see if each and every one of the frills is necessary to your installation, to your needs.

First, decide exactly what you want of your CB installation. Most often the SWLer in his shack wishes to communicate to one or more base stations.

You and your SWL pals can select one channel (or maybe two) on which to communicate. You don't need the full 23-channel rig. A 3 or 6-channel CB transceiver will do the job inexpensively.

Next, let's really think about the chrome trim and the wood-grain finish—pretty, but it doesn't make the old signal any louder, does it?

You get the idea: Start evaluating things like clocks, variable sensitivity, and other cost-adding features. How often will you use a public-address system, for instance? Start scratching these features from your list.

What's Available. Now, let's see what you might buy. You could go to Radio Shack and buy their TRC-9A rig, 3 channels and only $59.95. Lafayette offers a Micro-66 which has 6 channels and costs only $69.95! Yes—look through the catalogs—there's the Royce 1-590 ($69.95), the Midland 13-801 ($79.95), and all of the rest. Many manufacturers produce CB rigs for under $80, and you'll be surprised to see that they aren't all bare-bones models; most seem to be rather nicely designed and several incorporate a few deluxe features. Of course these CB rigs require a regulated 13.8-volt power supply to operate the rig at home. Cost for the power supply is about $30 or less.

A Roof-Topper. Now we get to the antenna, which you need to radiate your signal. If you absolutely *must* get the very last drizzle of signal into a remote corner of the county, you will probably require an expensive band-blaster running several hundred dollars. Want good general coverage? Well, don't overlook the old CB standby, the *ground plane* type antenna. There was a time when every CB base station used one, and you can still get them for about $12.95 and it will let you communicate in all directions without the need of a rotor to turn it, and it will send out your signal for about as much distance you would need for normal local communications. If you choose to operate the CB in your car, save money by purchasing any inexpensive mobile antenna that catches your fancy. Mobile antennas are all so well designed today that it would be hard to find a lemon at any price, even if you went looking for one.

If you've heard that to stretch your coverage you must put your base station antenna atop a tower, that is quite true. Now, maybe you can get adequate coverage with the antenna right on the roof of the building and you can avoid the whole question—for a base station antenna atop the roof (or chimney) of even a 2-story frame house will cover most suburban communities. A jazzy communications tower which will run your antenna up 50 feet will probably set you back $175 to $350. But here's a suggestion which can save you big cash: check out the prices of telescoping TV masts. You can get a 50-footer for less than $25, and it will hold up your ground plane with ease. And if you don't need quite that much height, there are all sorts of telescoping TV masts of lesser heights for lower prices.

You may also come to feel that the coaxial cable which feeds signals between the CB set and antenna is a vital link in your ability to effectively communicate, and, in actual fact, it is. Some CB operators go to hysterical ends to insure that not even the most miniscule pinch of signal is lost in the process. Towards this end they purchase sophisticated low-loss cable which sets 'em back at least 20¢ per foot—a 50-foot run of the stuff costs $10, plus the cost of the connector at each end. The amount of loss, however, that they would have suffered in 50 feet of less expensive type RG-58A/U coaxial cable would have been insignificant to the point of being practically undetectable in their most difficult communications. A 50-foot length of RG-58A/U cable would cost about $3.70, and the two connectors 60¢ each—or you can buy the cable with the connectors already attached for $6; and since putting the connectors onto the cable is a tricky soldering job for a novice, it's an afford-

Midland 13-801 is a "Plain Jane" CB rig for the no-frills, low-budget buyer. Three-channel operation with full power is all you need—why buy more?

CIRCLE 14 ON READER SERVICE COUPON

able luxury you might wish to use to your advantage.

The Bottom Line. Now let's see where we stand—a CB rig for about $80, a $13 antenna atop a $25 mast, connected together with $6 worth of cable. Grand total, including a few extra dollars for miscellaneous hardware: about $125 for a complete, effective, and versatile CB station—about 1/10th the cost of going the full route!

Maybe you'd like to think of it as a 90 percent discount, or a $1200 rebate—for certainly you will have effective local coverage with this shoestring CB station. After all is said and done, what more did you really want?

The editors of ELECTRONICS HOBBYIST are providing readers with a free booklet from the Electronics Industries Association (EIA) about CB radio. If you would like a copy, just fill out the coupon, check the correct box, and send it in. And don't forget "Kathi's CB Notes" for straight info on how to get and fill out an FCC license application. And if you want to stay current on what's happening in CB, follow Kathi Martin's CB column in every issue of ELEMENTARY ELECTRONICS. ■

Kathi's CB Notes
ELECTRONICS HOBBYIST
229 Park Ave. South
New York, N.Y. 10003

☐ Yes, I'd like to receive the EIA booklet about CB radio.

☐ I would also like to receive information about the specific CB products advertised in this issue.

☐ Be sure to include copy of "Kathi's CB Notes."

Name (Please Print)

Address

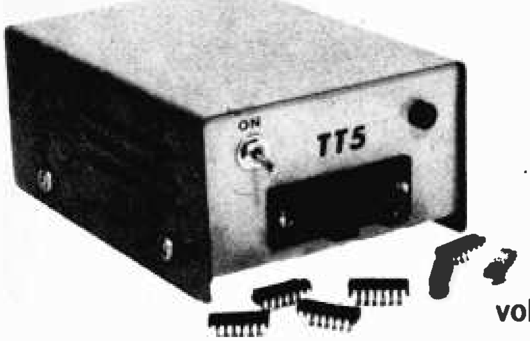
City

State Zip

CIRCLE 11 ON READER SERVICE COUPON

Lafayette Micro-66 full-power 6-channel CB rig is about as small as they come. Optional extra accessories include an AC power supply for home operation and portable battery pack for back packers.

Realistic TRC-9A 3-channel CB transceiver is ideal for monitoring the CB band with its external loudspeaker hook-up provision. Yep, it packs full power and good performance.



Hobbyist Power Supply For TTL

TTL-type digital integrated circuits require a steady 5 volts for superior operation. Get ready for TTL projects with this ultra-simple, high performance regulator.

by Herb Friedman

ELECTRONICS IS going digital! Not only are space TV photos relayed by digital techniques, but inter-country TV sound across the big pond (Europe) uses bits to represent audio. Right here in the U.S. we find TV receivers and FM tuners are "going digital." Even hobby projects such as you'll find here in e/e are using digital ICs.

The 7400 series of digital ICs is presently the most popular digital device "family," primarily because of its rock-bottom cost and easy handling; and it is more than likely that many hobby or experimenter projects you're going to run across in the next year or so will use the 7400 series of TTL (Transistor Transistor Logic).

The only problem is that TTL almost always requires a tightly regulated 5-volt power supply, and take careful note of those words *tightly regulated*. Often, the 7400-series device will instantly "blow" if 6 volts or a line transient is applied. The margin for error when working with TTL is essentially zero. While a zener diode can be used to provide, say, 5.1 volts, they are not easy for the average experimenter to find, nor do they necessarily provide protection against line voltage transients or short circuit protection.

What's needed is a full voltage regulator having both current and short circuit protection. Should the supply run hot due to excess current drain, or should a wiring error or breakdown in the external circuit short-out the power supply, the supply will automatically turn off, thus protecting both the power supply components and the connected circuit.

While you can always use a handful of components to build a 5-volt regulated supply for TTL—assuming you could possibly find the necessary components in your area—it's much easier to use a LM-309K, a single IC that contains *all* the components of a power supply regulator in a standard TO-3 case. Best of all, the LM-309K can be purchased locally for about $2.50; and that's probably less than the cost of discrete components if you decided to build from scratch.

Inside Look. The LM-309K 5-Volt Regulator is available from many surplus dealers and Radio Shack. Mounted on a PC (printed circuit) or perfboard, it can safely deliver up to 1 ampere. Mounted on a heat sink you can squeeze out 3 amperes. The LM-309K gives the average experimenter everything he's looking for in a TTL power supply: tight regulation, transient protection, thermal shutdown, and short circuit turn-off.

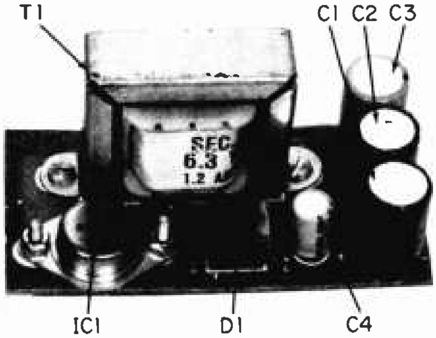
A typical TTL 5-volt supply using the LM-309K that's suitable for the experimenter is shown. It's a rather easy circuit to build and provides 5 volts at up to 1 ampere with the IC mounted on a PC board. If you want to avoid the fuss and bother of making your own PC board, you can use a pre-drilled factory-made board which we'll describe later.

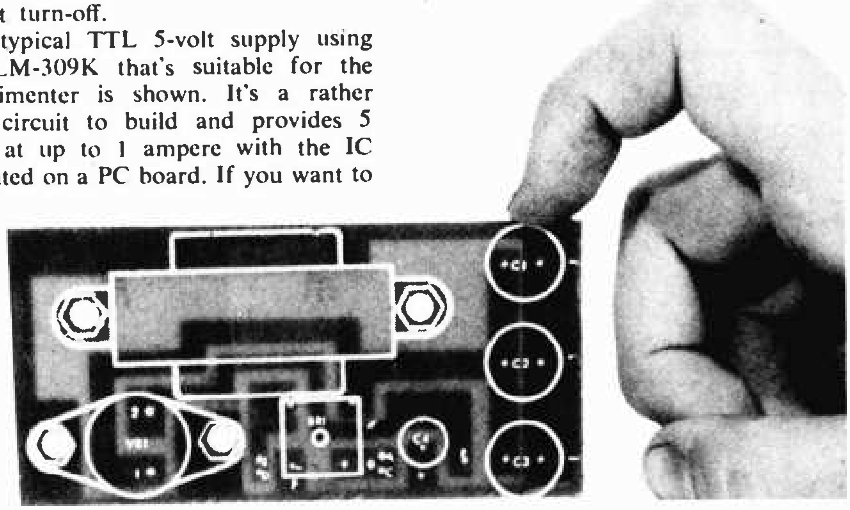
Transformer T1 is an ordinary 6.3-volt filament transformer rated at least 1 ampere. Capacitors C1, C2, and C3 can be replaced with a single 3000-uF unit rated at least 15 volts, but you'll find it much easier to locate three 1000-uF capacitors. Diode bridge D1 should be rated 5 to 6 amperes to handle the peak current load of the heavy filtering (C1, C2, C3). Do not try to get by with a 1-ampere bridge rectifier.

Capacitor C4 provides a low power supply impedance to the connected circuit; do not eliminate C4. Also, pilot lamp I1 should not be eliminated or its position in the circuit changed because it is used to discharge C4 when the power supply is turned off. Without I1 C4 might retain a charge for several minutes after the 117 VAC input power has been removed and can cause headaches and grief. When? Suppose you connect up your project thinking there's no voltage from a supply that's turned off!

To insure long life, and since the

The completed supply ready for installation in a cabinet or project. Pilot lamp I1, which also serves to discharge the output capacitor, is not part of the PC board assembly.





Easiest way to build the power supply is to use this Radio Shack PC board. All holes are pre-drilled and the component positions are "screened" on the top side. Back-lighting shows the heavy copper foil showing through; it means customization without fear of damage to the foil strips.

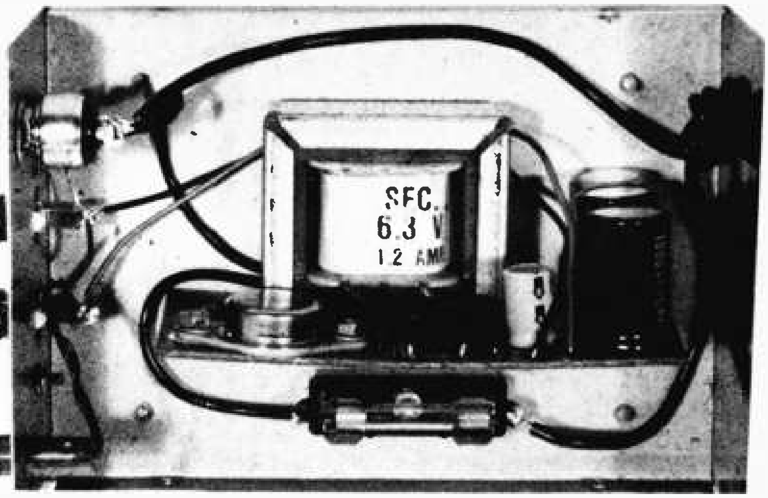
pilot lamp doesn't have to be bright enough to read by, I1 is a 12 volt/25 mA lamp—one of those miniature pilot assemblies that comes with attached leads. Connected to 5 volts, it's bright enough to see even in sunlight.

The supply shown in the photographs is assembled on a factory pre-drilled PC board available from Radio Shack for $1.49. The top side has the component locations screened in white paint. While the transformer mounting holes are spaced for the Radio Shack 273-050 6.3-volt filament transformer, you can, however, use any rated transformer although you may have to drill new holes. A rear-lighted photograph shows the extra-wide copper foil that permits easy customizing of the PC board.

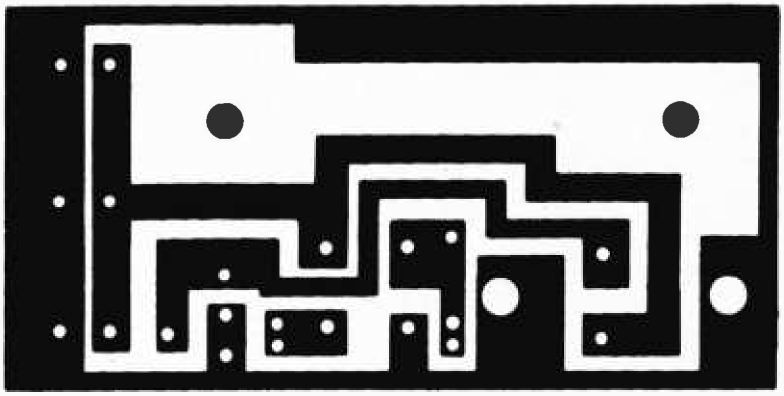
More Data. The instructions supplied with the Radio Shack PC board indicate a different pilot lamp connection than shown in our schematic. For this supply do not follow the Radio Shack connections; install the pilot lamp exactly as indicated in our schematic.

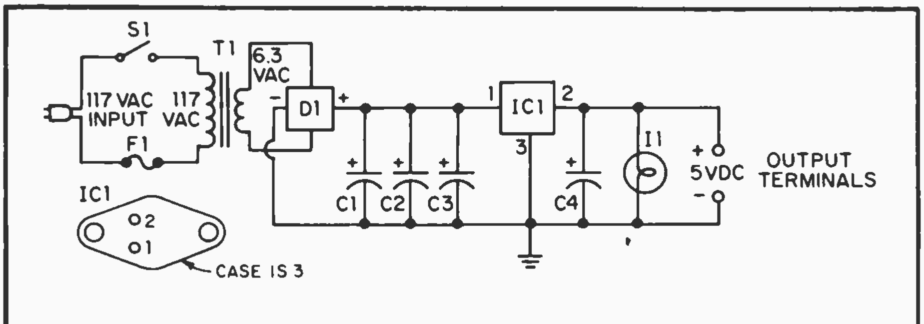
The entire supply—except for power switch S1, pilot lamp I1, and fuse F1—is on the PC board which you can install in any type of cabinet. The complete supply shown uses a 4 x 2⅜ x 6-in. metal cabinet, with the PC board end mounted by L brackets fashioned from scrap aluminum. The fuse holder is mounted on the base of the cabinet. Output is from two spring-loaded pushbutton terminals, but you can substitute 5-way binding posts or any other output connections you prefer.

Fuse F1 can be anything from ⅛ to ¼ ampere. Use a standard fuse such as 3AG—not a slow-blow type.



Just one example of a suitable cabinet installation, though any layout will work. The fuseholder is mounted on the cabinet base, while pilot lamp I1 is connected directly across the output binding posts. An old plastic cap was used to give the base lamp a professional appearance.


This is the copper side of your circuit board drawn to its correct size. You can purchase it preetched and drilled, or place carbon paper on a copper clad board, trace the outline onto the board, and use etching solution to make your own board.



PARTS LIST FOR TTL POWER SUPPLY

C1, C2, C3—1000-uF, 15-VDC or higher electrolytic capacitor, see text
C4—100-uF, 15-VDC or higher electrolytic capacitor
D1—50-volt, 6-amp diode bridge rectifier
F1—¼-amp fuse, fast-acting
I1—12-volt, 25-mA pilot lamp, see text
IC1—LM-309K IC voltage regulator (National Semiconductor Corp.)
S1—spst switch
T1—6.3-VAC, 1-amp or better transformer
Misc.—cabinet, fuse holder, pushbutton or other type terminals, circuit board (optional), wire, solder, hardware, etc.

Too Hot. If the last things you solder are the IC terminals, let everything cool down before you check out the supply. If IC1 is excessively hot—from soldering heat—the automatic thermal protection shuts down the output and you won't get any output voltage. A meter connected across the output terminals will indicate zero. After you are certain IC is cool, measure the output; it should be 5 volts. Next, connect your voltmeter across either C1, C2, or C3, then short circuit the output terminals. If you have assembled everything correctly the meter will indicate approximately 10 volts even though the output is shorted. After the short is removed you should read 5 volts at the output terminals.

The only thing to keep in mind when using this TTL 5-volt supply is that the output current is automatically limited to 1 ampere. ■

BGNRS FET IC BCB AM RCVR*

***beginners field effect integrated circuit broadcast band amplitude modulation receiver**

THE BEST WAY for the newcomer to radio to learn about receivers is to build one! The easiest type of receiver to build that will be reasonably selective and sensitive is the type that grandad built back in the golden days of radio—the regenerative receiver. But this one has been brought up to date. Instead of old-fashioned tubes, this receiver uses a field effect transistor (FET) regenerative detector and an integrated circuit (IC) for the audio amplifier.

Our model tunes the broadcast band from 550 kHz to 1600 kHz; it provides very reliable reception for the beginner. The receiver is built in a handy metal cabinet, runs on two dry cells, and is designed for simplified construction with perf board mounting of components. The receiver can be used with earphones for digging out the broadcast band DX, and it will operate a speaker when tuned to strong local stations.

Circuitry. Signals from the antenna at J1 are coupled via the antenna trimmer capacitor C1 to the tuned circuit L1-C2 and then detected and amplified by the gate-leak detector Q1. Some of the RF energy is fed back from Q1 to L1-C2 via the tickler coil L2, then detected and re-amplified again by Q1. The amount of RF energy feedback is adjusted by the REGEN control, R1, in shunt with the tickler coil L2. When there is too much feedback, the gate-leak detector Q1 circuit will oscillate, an undesirable condition.

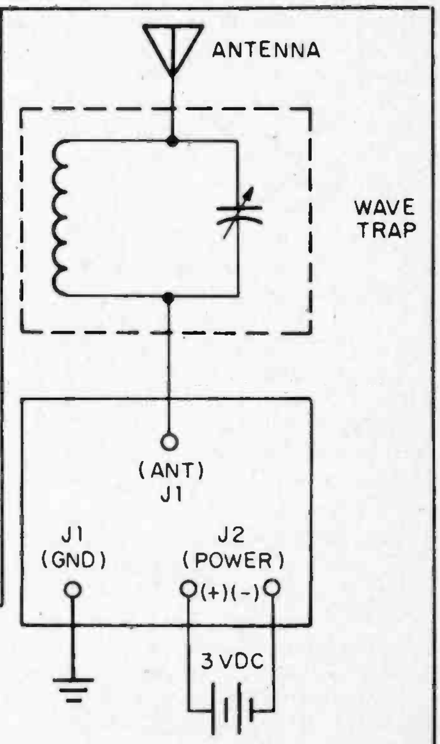
Detected signals from Q1 are coupled through C7 to the integrated circuit and amplified. The amplification is controlled by R7, and the audio output is coupled to J3 for an external speaker (8 to 45 ohms), or earphones. A 3-volt battery or DC power supply is connected to J2 to supply the necessary electrical power for the receiver circuits.

Construction. The FET-IC receiver is built in a 5¼-in. deep by 3-in. high by 5⅞-in. long metal cabinet. Most of the components are installed on a 4¼-in. by 4½-in. perf board section. The remaining parts are mounted on the front and back panels of the cabinet. The parts placement is not critical, but for best performance follow our component layout and wiring placement.

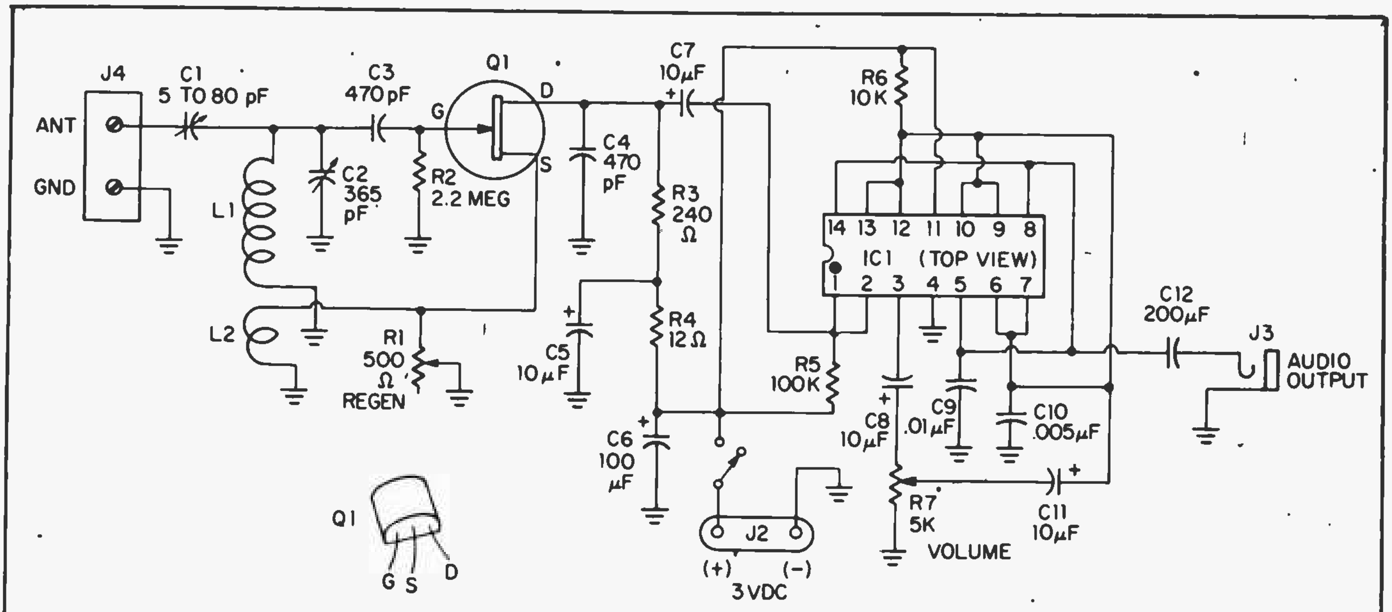
The RF coil L1 is wound on a 2-in. long section of 1¼-in. (outside diameter) plastic tube. A type of plastic tube used for protecting golf clubs—obtainable in sporting goods stores—is used for our coil form. But a cardboard mailing tube 1¼-in. in diameter can also be used.

Begin construction by tightly winding #28 enameled copper wire in a single layer over 1½-in. of the coil form. It's not necessary to count the turns, as the coil may have to be modified to fit your particular antenna. Connect the wire ends through holes at each end of the coil form and connect the wires to two solder lugs mounted at one end of the coil form (see photos). Set the coil aside.

Install the front and rear panel com-



Simple diagram of wavetrap as it is connected to the receiver. Simple parallel tuned circuit provides an extra measure of selectivity.



PARTS LIST FOR BEGINNER'S FET-IC BCB RECEIVER

C1—5 to 80-pF trimmer capacitor (see text)
C2—365-pF variable capacitor
C3, C4—470-pF ceramic or mica capacitor
C5, C7, C8, C11—10-uF, 3-VDC or better electrolytic capacitor
C6—100-uF, 3-VDC or better electrolytic capacitor
C9—0.01-uF capacitor
C10—0.005-uF capacitor
C12—220-uF, 3-VDC electrolytic capacitor
IC1—quad 2-input gate, RTL-type (Motorola HEP570 or equiv.)
J1, J2—screw-type terminal strip
J3—phone jack
L1—RF coil: #28 enamel wire wound 1½-in. on 1¼-in. dia. coil form (see text)
L2—tickler coil: 2 turns hookup wire wound on L1 (see text)
Q1—FET (Motorola HEP802 or equiv.)
R1—500-ohm linear-taper potentiometer with spst switch
R2—2.2-megohm, ½-watt resistor
R3—240-ohm, ½-watt resistor, 5%
R4—12-ohm, ½-watt resistor, 5%
R5—100,000-ohm, ½-watt resistor
R6—10,000-ohm, ½-watt resistor
R7—5,000-ohm audio-taper potentiometer

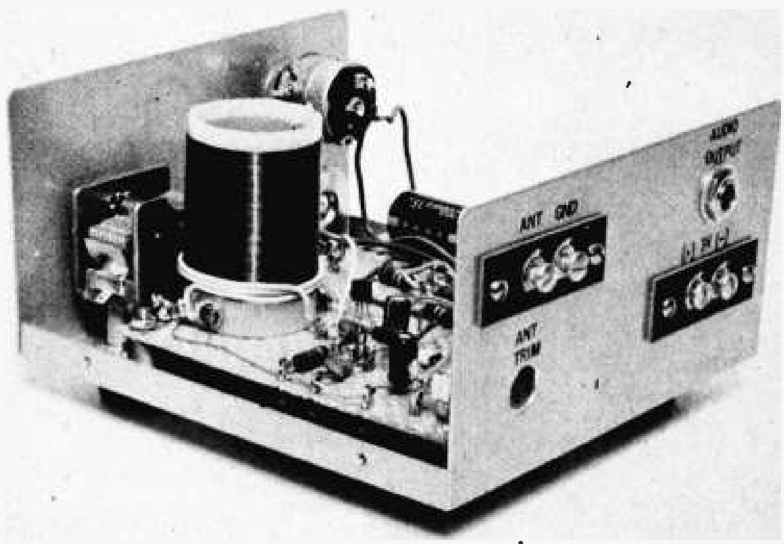
Misc.—metal cabinet 5½ x 3 x 5⅞-in., perf board and push-in clips, 1¼-in. dia. coil form (see text), metal spacers, hookup wire, knobs, 3-volt battery or 3-VDC power supply, high-impedance earphones or speaker (see text), wire, solder, etc.

ponents as shown in the photos. Capacitor C2 is mounted on two ½-in. metal spacers on the box bottom and as close as possible to the front panel. Mount the 4¼-in. by 4½-in. perf board on the box bottom with a ⅜-in. spacer at each corner.

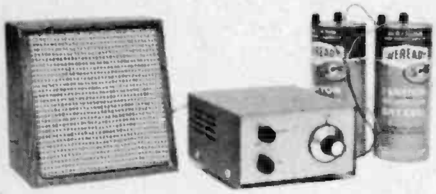
To Continue. Temporarily position the trimmer capacitor, C1, at the rear corner of the perf board (located as shown in the photos) and mark and drill a ⅜-in. access hole in the rear panel for the C1 adjustment screw. Mount the RF coil L1 on the perf board near C2 by soldering one of the coil lugs to a ground lug installed on the nearby corner mounting screw, and solder the other coil lug to a push-in clip on the perf board. Wind two turns of hookup wire around the base of L1 (in the same direction as the L1 winding) and connect the start of the winding to the ground lug, and the finish of the winding to a push-in clip on the perf board. This winding is the tickler coil L2, and may have to be adjusted for best operation.

Lay out and wire the perf board components as shown in the photos and schematic drawing. In our model, the leads of IC1 are flattened out and soldered to push-in clips for connections to the circuit. Of course, an IC socket can be used if mounted on the board by soldering its contacts to push-in clips.

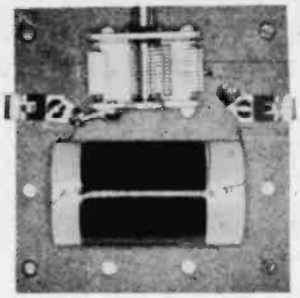
Connect the front and rear panel components to the perf board circuits as shown in the schematic. Make sure that the connecting leads to C1, L1, L2, R1, C3 and the "gate" lead of Q1 are as short and direct as possible. Keep these leads up in the air and away from all the wiring of IC1. Complete the



Use perf board and push in clip construction for your receiver. It's simple and avoids the pitfalls of loose components and shorting wires. Solder lugs are bolted to opposite sides of the coil form and then soldered to two push in clips.



Alternate method of listening to your radio. Although audio power output is low, strong local stations produce a reasonable sound.



Use a short piece of wire to connect one terminal of the wave trap to the radio. Clip your longwire antenna to the other wave-trap terminal and tune out interference.

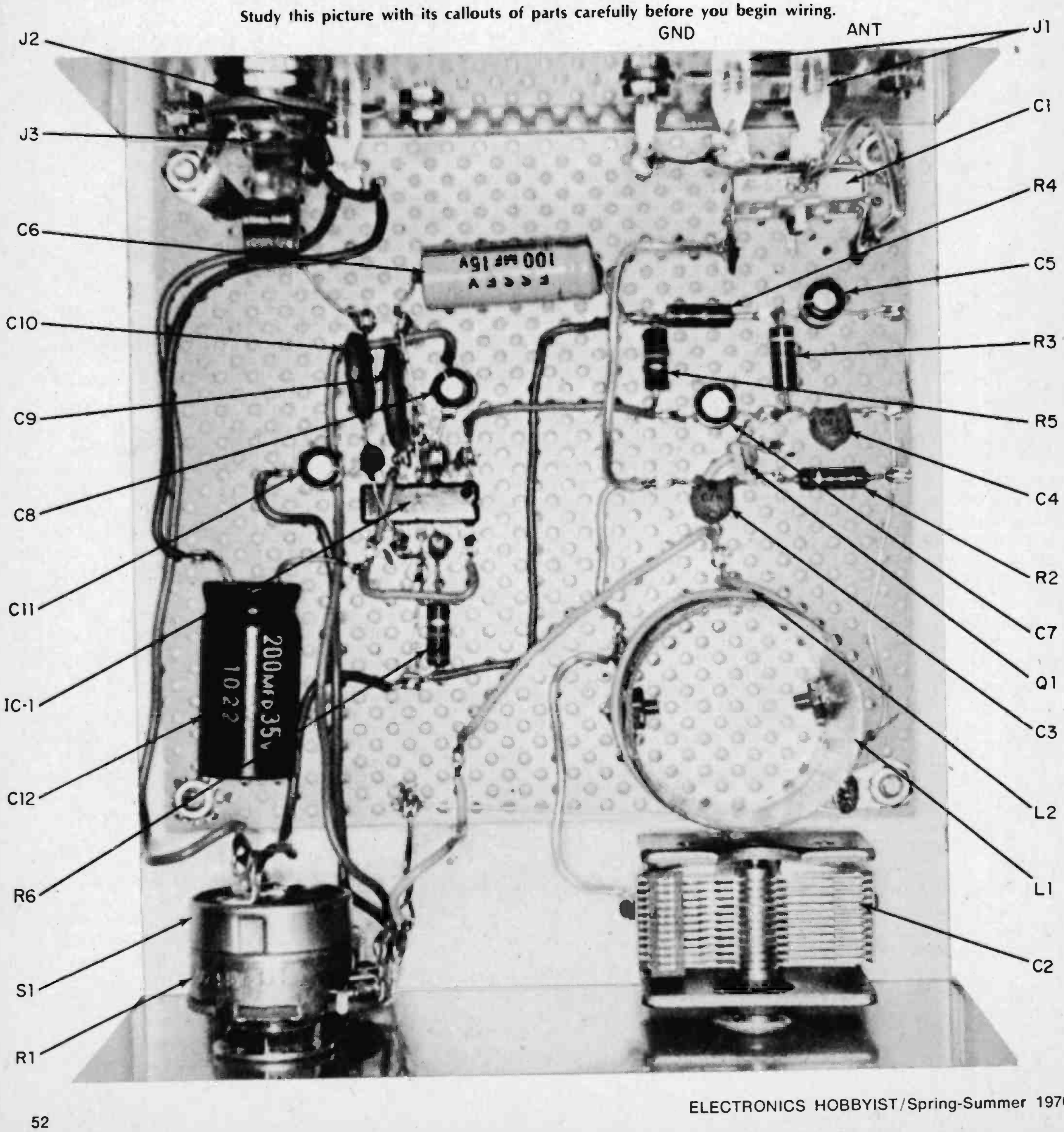
wiring of the receiver. Make sure that all wiring is fastened so that it will not move about.

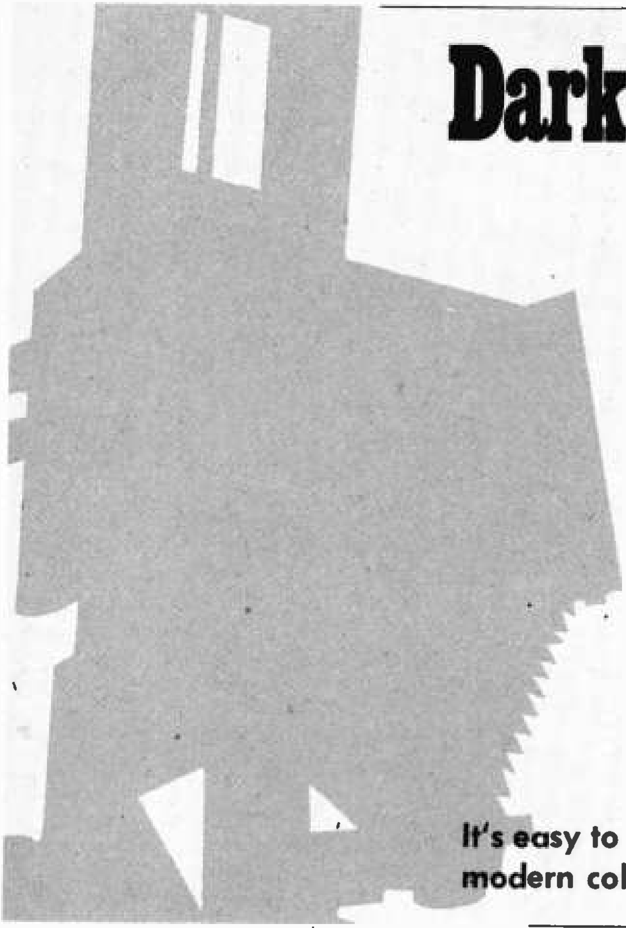
Operation. For best reception, an outside long wire antenna and a good ground (fastened to a cold water pipe) are required. The antenna should be as long as possible and mounted high up in the air. The mail order houses have antenna kits available which come complete with the necessary insulators and lead-in wiring.

Connect the antenna lead to the ANT terminal of J1 and connect the ground lead to the J1 GND terminal. Connect

(Continued on page 98)

Study this picture with its callouts of parts carefully before you begin wiring.





Darkroom Color Analyzer

by Herb Friedman

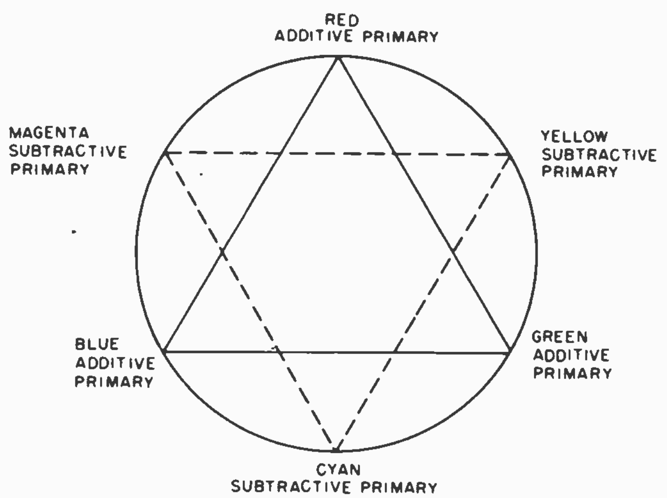
It's easy to make quality, bright color prints at home with modern color chemistry and this electronic color analyzer!

ONE OF THE SHUTTERBUG'S most satisfying accomplishments is producing his own color prints. For years the time spent on and the cost of making color prints were discouraging, but with modern color chemistry, such as the Beseler system, you can turn out quality color prints *in less time than for black and white* (about 3 minutes), and the prints will be far superior to anything you're likely to get from a color lab.

One thing that takes the drudgery out of color work—besides the chemistry—is a color analyzer, a device that gives you the correct filter pack and exposure time at the very first crack. Most often, the very first print made with the analyzer will be *good*. At most, it will take perhaps 0.10 or 0.20 change of filtration for a *superb* print. This is a lot less expensive and time-consuming than making test print after test print. In fact, it's really the color analyzer that puts the fun into making your own color prints!

Color Analyzers Are Not Cheap. A decent one costs well over $100, and a good one runs well over $200. But if you've got even a half-filled junk box you can make your own color analyzer for just the junk parts and perhaps $10 to $15 worth of new components.

A color analyzer is basically a miniature computer. You make a "perfect" print the hard way—by trial and error—and then calibrate the analyzer to your filter pack and exposure time. As long as you use the same box of paper and similar negatives, all you need to do to make a good color print is focus the negative, adjust the filter pack and exposure so the analyzer reads "zero," and hit the enlarger's timer switch. Even if you switch to a completely different type of negative, the analyzer will put you well inside the ballpark, so your second print is a winner. (And even if



Any one of the primary colors on this circle is composed of its immediately adjacent colors in equal amounts. Each primary color is also complementary to the color directly across the center of the circle. Complementary colors added together form neutral densities. It is the balancing of additive primary colors of photographic light sources and subtractive-type color filters that provides control in color print photography.

COLOR ANALYZER

the filtration is off, the exposure will probably be right on the nose.)

Construction. The color analyzer shown was specifically designed for the readers of this magazine—essentially an electronics hobbyist with an interest in photography. All components are readily available in local parts stores or as junk box parts. Several protection devices have been designed into the circuit so accidental shorts won't produce a catastrophe. The printed circuit board template has foils for both incandescent and neon meter lamps, as well as extra terminals so you can use either a socket and plug or hard wiring for the color comparator and exposure sensor. In short, you can make a lot of changes to suit your individual needs.

The template for IC1 uses a half-minidip, Signetics V-type package lead arrangement. However, you can also use an IC with a round (TO-5) configuration. If anything is wrong with the IC you can get the TO-5 out easily. The half-minidip removal might result in destruction of the PC board. We'll explain how to install the TO-5 IC on the PC board later.

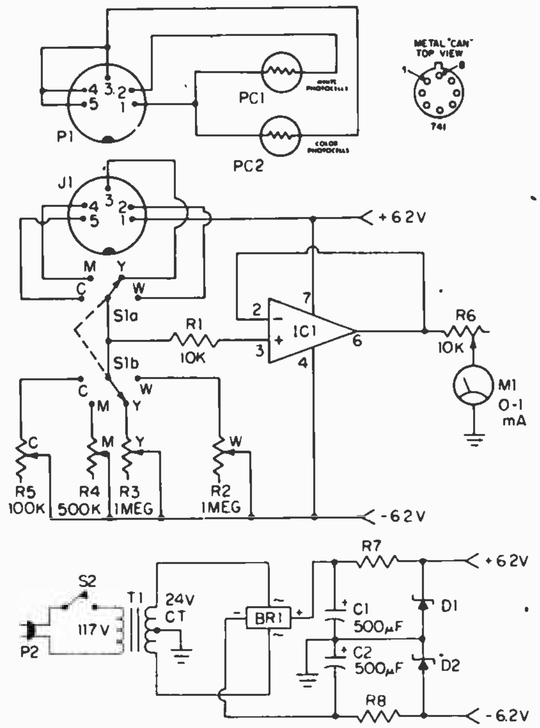
You can either buy or make the printed circuit board (see parts list). Either way, the first step is to prepare the printed circuit board. If you do it yourself, make it any way you like, using free-hand or template resist. Nothing is critical, but be certain there are no copper shorts between the terminals for IC1. Use a #56 bit for all holes. Then use a larger bit for transformer T1's mounting screws (#4 or #6 screws), a ¼-in. bit for resistor R6, and a #30 to 40 bit for the linecord connections (any bit that will allow the linecord wires to pass through the board).

Assemble the power supply and check it out before any other components are installed. Install transformer T1 first. Any 24-volt or 25.2-volt center-tapped transformer that will fit on the board will be fine. Get something small, like 100 milliamperes. A Wescom 81PK-100 is a perfect fit.

Bridge rectifier BR1 is the low cost "surplus" found in many distributors. This type has the positive and negative outputs at opposite ends of a diamond. The AC connections are the remaining opposite ends. Note that BR1 is installed in such a manner that its negative output is farthest from transformer T1 while the positive output is nearest to T1. Make certain your bridge rectifier has the same lead configuration; if it is different, modify the printed circuit template to conform to the rectifier you're using. Get it right the first time.

Finally, install C1 and C2, R7 and R8, and zener diodes D1 and D2. Take care that the capacitors and zener diodes are installed with the polarity correct. If the capacitors have their negative leads marked with an arrow or line, these markings face the *opposite edges* of the PC board (negative to the outside). The zener diodes are installed so that their cathodes (the banded ends) face each other towards the center of the board.

Initial PC Checkout. When the power supply is completed, temporarily connect a linecord. Connect the negative lead of a meter rated 10 volts DC or higher to the foil between T1's mounting screws (that's ground). Connect the meter's positive lead to the junction of R7 and D1, which is in the center of the board; the meter should indicate approximately +6.2 volts DC. Then connect the positive meter lead to the R8 and D2 junction, which is near the edge of the board. You should get approximately −6.2 volts DC. If the voltages



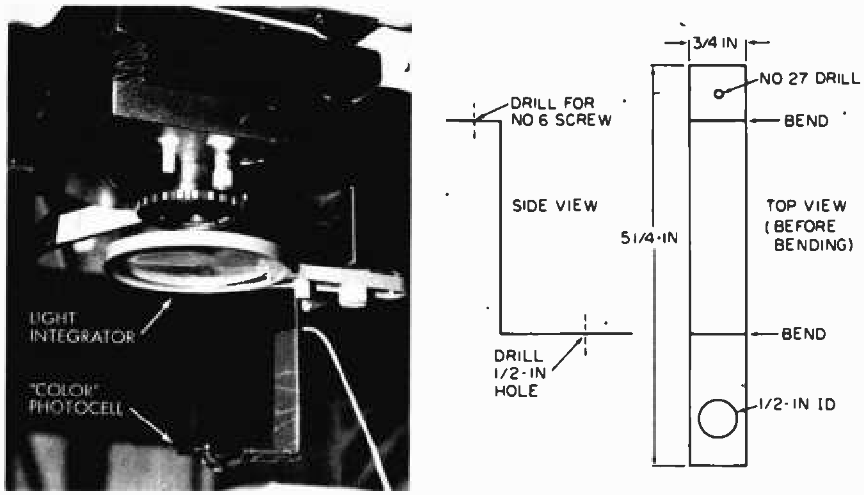
PARTS LIST FOR COLOR ANALYZER

BR1—50-PIV, 0.5-amp or higher silicon bridge rectifier
C1, C2—500-uF, 10-VDC or better electrolytic capacitor
D1, D2—6.2-volt, 1-watt zener diode
IC1—type 741C operational amplifier, see text
J1—5-pin socket, DIN-type (optional, see text)
M1—0 to 1-mA DC meter, see text
P1—5-pin plug, DIN-type (optional, see text)
PC1, PC2—Clairex CL5M5L photocell, **do not substitute**
R1—10,000-ohm, ½-watt resistor
R2, R3—1-megohm potentiometer, see text
R4—500,000-ohm potentiometer, see text
R5—100,000-ohm potentiometer, see text
R6—10,000-ohm trimmer potentiometer (Mallory MTC-14L4 for exact fit on PC board)
R7, R8—820-ohm, ½-watt resistor
R9—100,000-ohm, ½-watt resistor
S1—2-pole, 4-position rotary switch (Allied Electronics 747-2003; adjust stops for 4 positions)
S2—spst switch
T1—117-volt primary, 24 to 26.6-volt secondary transformer, see text for point-to-point wiring (Note: you can also use two less expensive 12-volt transformers with secondary windings connected in series-aiding, if you have the space.)

The printed circuit board for the Color Analyzer is available direct from Electronics Hobby Shop, Box 192, Brooklyn, NY 11235 for only $5.50 (including postage and handling). Canadian shipments add $2 extra. New York State residents must add sales tax. No foreign orders, please. Postal money orders will speed delivery; otherwise allow 6-8 weeks for delivery.

If you cannot obtain the Clairex Type CL5M5L photocell locally, write to Electronics Hobby Shop at the above address, enclosing $3 for each photocell. Postage and handling are included. No Canadian or foreign orders. New York State residents add sales tax. Postal money orders speed delivery; otherwise allow 6-8 weeks for delivery.

Misc.—cabinet, pilot lamp for meter, 2-in. or 3-in. size Kodak Wratten filters #70, #98, and #99 (available from photo supply dealers), calibrated knobs, wire, solder, hardware, etc.



The color comparator photocell Z-bracket is installed under a light integrator. If your enlarger has a filter holder under the lens, attach the Z-bracket to the holder.

are far apart in value, or if the polarity is wrong, make certain you find the mistake *before* installing IC1.

Disconnect the linecord and complete the PC assembly. If you use a 24 or 28-volt pilot lamp to illuminate the meter you connect to the holes adjacent to T1's secondary (24-V) leads. If you plan to use a neon illuminator, install a 100,000-ohm resistor (R9) on the PC board and connect the lamp to the holes marked "neon." The lamp must have as little illumination as possible. Incandescent 24 or 28-volt lamps must be the miniature or "grain of wheat" type rated approximately 30 to 60 mA; the lamps come with attached leads. Do not use pilot lamps of the 100 to 500 mA variety. The excessive light will confuse the analyzer.

To install IC1 when it is the metal can TO5 type, fan out the #1 to 4 leads and #5 to 8 leads so they form two straight lines. Note that the lead opposite the tab on a TO5 package is #8. Insert the leads into the board leaving about ¼ inch between the IC and the board. The IC is correctly installed if the tab faces *away* from the transformer towards the nearest edge of the PC board. Solder IC1 and cut off the excess lead length.

The edge of the PC board nearest IC1 has four sets of paired foil terminals. These are provided as mounting terminals if you connect the photocell comparator and sensor without the use of a plug and jack. However, we strongly suggest the use of the specified DIN-type connectors as they allow for easy repairs if the connecting wires break. (The connectors aren't *that* costly).

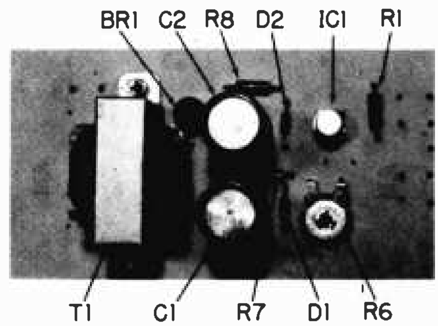
Potentiometers R2 through R5 can be linear or audio taper, though audio taper gives a slightly smoother adjustment; use whatever you have in stock.

The analyzer shown is built in a Bud 7-inch AC-1613 Universal Sloping Cabinet. This is the least critical item and you can substitute whatever cabinet you prefer. Just be certain the cabinet will accommodate the type of meter you use.

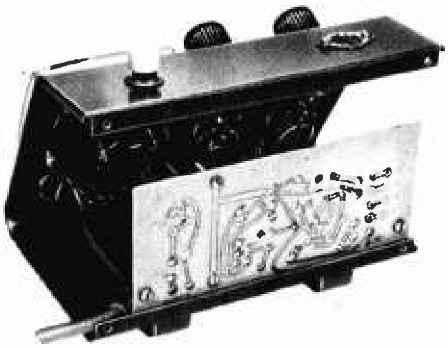
Meter M1 should be 0-1 mA with a zero-center scale. But these are expensive, so you can substitute any standard 1-mA meter you want. You will simply calibrate the instrument for zero-center.

If you use a neon pilot lamp mount it directly above the meter and shield the forward brilliance with a piece of black tape; the lamp should radiate straight down onto the meter scale. If you use the meter in the parts list, remove the front cover by pulling it forward. Then remove the meter scale. As shown in the photographs, place a black dot approximately 3/16-inch wide at the center of the scale. If you want, you can also modify the meter for the incandescent lamp. Drill a ¼-inch hole in the lower right of the meter *from the rear.* Position the meter in the cabinet and mark the location of the meter hole on the panel. Remove the meter and drill a ⅜-inch hole in the panel. When the meter is installed you can pass a "grain of wheat" lamp through the panel into the meter. Reassemble the meter and complete assembly.

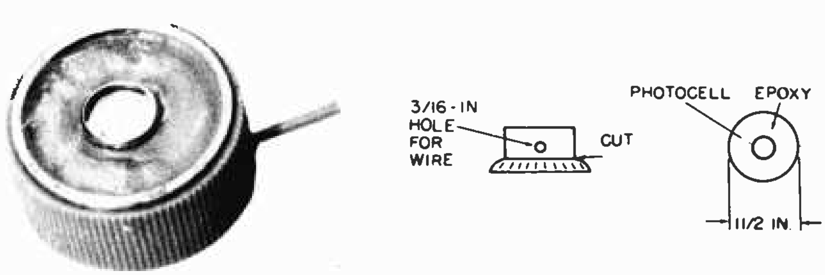
The Comparator. The photocells used for the comparator and exposure sensor, P1 and P2, must be Clairex type CL5M5L. Make no substitutions. From a piece of scrap aluminum ¾ to 1 inch wide, fashion a Z-bracket to the dimensions shown. Drill a ½-inch hole close to the end of the longer Z-leg. Fasten the other end of the Z-leg to your enlarger's under-lens filter holder. If your enlarger does not have a filter



This is the parts location when our PC board is used. To get a free template of the PC board, send a Self-Addressed Stamped Envelope to: Davis Publications, Dept. T, 229 Park Ave. South, New York, NY 10003.



Rear view of author's color analyzer shows vertical mounting of the circuit board.



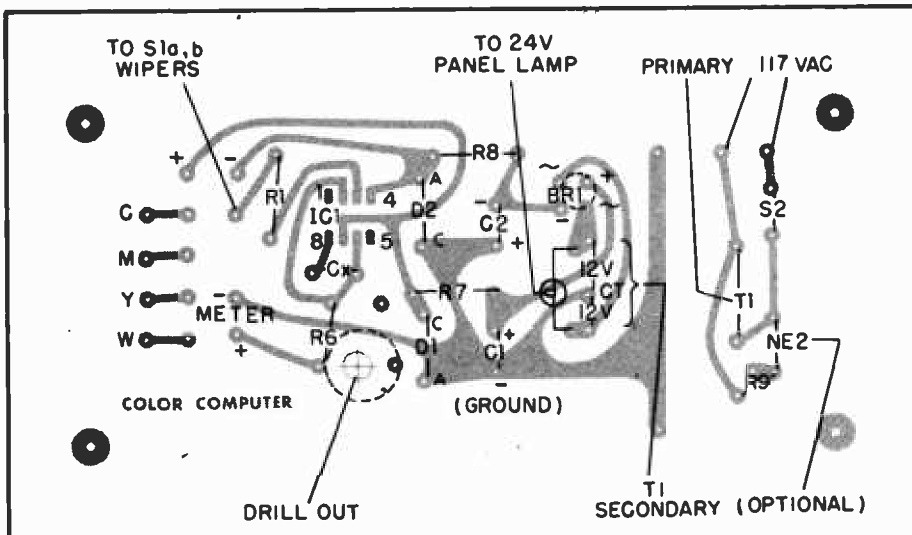
The exposure sensor photocell is mounted in anything that will keep it in place on the easel. This example was epoxy-cemented into a large control knob after the outside dial section was ground off. In typical operation, the sensor is placed under the lens with the light integrator or filters.

holder, or if it has a permanent swing-away red filter under the lens, mount a Paterson swing-away light integrator (available from local photo shops) under the lens. Fasten the short leg of the Z-bracket to the integrator—which has pre-drilled holes—so that the ½-inch hole is on the optical center of the lens. Then cement photocell P2 in the hole and attach the connecting wires; these can be extra-thin zip cord such as used for short-length speaker connections. (This whole bit reads a lot more complicated than it is. Use the photographs as a guide.)

Photocell P1, which measures the exposure light, can be mounted in anything heavy enough to hold it in place on the easel. The photographs show the photocell epoxy-cemented in an oversize control knob.

When the complete analyzer is assembled, attach oversize calibrated knobs such as the Calectro E2-715 to R2 through R5. The knob calibrations are important so they should run out to the very edge of the knob skirt. If the calibrations don't run to the edge you won't be able to preset the controls with any reasonable degree of accuracy. Place a fine line or other indicator directly above each knob.

Checkout. Connect the photocells to the control unit and apply power. Don't worry if the meter pins at either end of the scale. Set switch S1 to the extreme clockwise position and adjust R2 through R5 until you find the control that changes the meter reading. Mark the switch and the control "C" for cyan. (We suggest you paint the cyan knob insert a blue-green. Also paint the other knobs the appropriate color.) Advance S1 one position clockwise, find the correct knob and label both "M" for magenta. Advance the switch another position clockwise, find the knob and label both "Y" for yellow. The last switch position and knob is labeled "W" for white (white light exposure). Make certain the C, M, and Y controls are reading P2, the color comparator mounted under the enlarger lens.



There are few parts on the PC board and nothing is critical. Modify the board if you wish. Trimmer potentiometer R6 should be a flat mount, so it can be adjusted through a hole in the cabinet.

Set S1 to any position, set all other controls to their mid-position, and turn on bright room lights. If the meter pins out or approaches full scale deflection, adjust trimmer control R6 so the meter pointer just pins (don't be afraid to pin the meter). Depending on the amount of light the meter pointer will pin right (for bright light) and left (for

Close-up of meter face showing a small scale-illumination lamp in lower right corner. This lamp should not be operated at full voltage to avoid fogging the film.

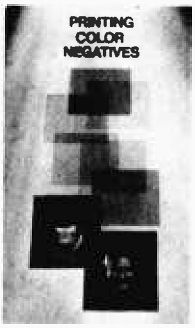
dark or very low light). This is normal and there will be no damage to the circuit or the meter. (Note: If you use a zero-center meter the pointer will barely pin on both sides.)

Install the Z-bracket under the lens. If your enlarger uses a filter holder under the lens insert a diffusion screen or glass, or a Beseler Light Integrator or similar ground glass in the filter holder. You are now ready to make color prints.

The first thing you need to make fine quality color prints is a high speed chemistry, such as the two-step Beseler system which can produce a finished print in two minutes. The second item you need is the electronic color analyzer for which we've already given you the plans.

Color Variables. Color materials such as the negative, printing paper, enlarger lamp, and even color correction filters vary in their sensitivity to light colors from batch to batch, roll to roll, and time to time. Even the enlarger's optical system can have a color cast. For this reason it is generally impossible to place a negative in your enlarger, expose the paper, and develop a good—let alone decent—color print.

To avoid upsetting a control setting while groping for the on-off switch in the darkroom, mount switch S2 as far as possible from the controls.



Provides a wealth of worthwhile info for photographers interested in the color print techniques available from Kodak or your photo dealer. Their publication No. E-66.

One way we can correct for these variables is through an *additive* exposure, exposing the paper through blue, green, and red filters for differing lengths of time. Since blue, green, and red create all the colors in additive printing, any correction can be obtained by controlling the precise timing of each exposure. The additive system is a pain in the neck for the hobbyist, for the slightest desired change in the color rendition or saturation (exposure) can involve changes in the exposure through all three filters.

A printing system that's easier to use and more favored by hobbyists is the *subtractive* exposure. A single filter pack made up of two of the filters known as YELLOW, MAGENTA, and CYAN makes all the color corrections at the same time. This filter pack is placed between the enlarger lamp and the negative; virtually all modern enlargers have a drawer in the lamphouse to accommodate a filter pack. A single exposure through the filter pack is all that's required to make a color print. Some of the more expensive enlargers have what is termed a "dichroic head" with variable filters as part of the light system; the exact value of filtration is simply dialed by the user. Again, all the color correction is provided at one time by the dichroic head so only a single exposure is needed.

More Info. A full and complete treatment of both types of color printing is contained in the Kodak publication *Printing Color Negatives;* this book is a required reference for anyone who wants to make quality color prints. The book also gives the most convenient operating procedures for electronic color analyzers.

The subtractive printing procedure is particularly well adapted for use with a color analyzer, is the easiest method for the amateur, and is exceptionally fast-handling, so the illustrations to follow will refer to the subtractive system.

An electronic color analyzer basically consists of a photocell (vacuum tube photomultiplier or photoresistor) positioned under the lens, blue, green, and red filters mechanically positioned over the photocell (or positioned over the cell by hand) and a meter that indicates the amount of light falling on the cell. The meter is connected to the photocell through independent potentiometers as shown in the figure. Color analyzer readings will be accurate for most negatives and lighting situations as long as the same box of printing paper is used. The system needs to be recalibrated only when the printing paper is changed (so purchase boxes of at least 100 sheets to avoid extra work).

The first step is to make a really fine print from a decent negative. You can do it the hard way, one print at a time, or use a Beseler Subtractive Calculator which puts you inside the ball park on the first try. When you have made a print with satisfactory flesh tones and color saturation don't disturb the enlarger or timer controls.

To Continue. . . . Place the color analyzer's probe on the easel or swing it under the lens (if it is mounted on the enlarger). Install a light integrator—which is nothing more than a piece of ground glass or its equal—under the lens, between the lens and the analyzer's probe. The light integrator scrambles the picture into a diffused "white light" which contains all the color elements of your negatives and the filter pack. Place a blue filter (Kodak Wratten No. 98) on top of the light integrator. (Note that most hobbyist analyzers have a selector switch that also mechanically positions the correct filter over the photocell.) Turn on the enlarger and adjust the analyzer's *yellow* control for a convenient reference meter reading. (Usually, center-scale or "null" is used as the reference reading, but any meter reading can be used as a null.)

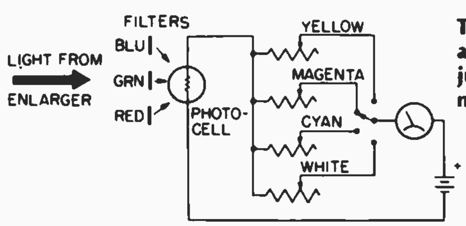
Remove the blue filter, install a green filter (Kodak Wratten No. 99), switch the analyzer to MAGENTA and adjust the *magenta* control for a null meter reading. Remove the green filter, install a red filter (Kodak Wratten No. 70), switch the analyzer to CYAN and adjust the *cyan* control for a null meter reading (the color controls yellow, magenta, and cyan refer to the color of the subtractive filters in the filter pack). Finally, remove all filters from under the lens, switch the analyzer to WHITE and adjust the *white* control (exposure control) for a null meter reading.

(The color analyzer in this project uses a separate photocell for the exposure. If you look at the easel you'll see a shadow cast by the Z-bracket holding the color comparator cell. Position the exposure cell on the easel so it is just off the edge of the shadow. If you prefer, you can place several thicknesses of opaque paper over the color comparator cell and use it for the white measurement, though we suggest you use the separate cell.)

Modern color print chemistry techniques from Beseler include this subtractive color calculator to aid filter selection.

When all the controls are adjusted you have programmed the color characteristics and exposure of your "reference" print into the analyzer, and you should note the control settings and exposure time for future use.

Down to Business. Now assume you want to make a print from another negative. Put the new negative in the enlarger. Then set the degree of enlargement and focus, leaving the lens wide open. Place the analyzer's probe under the lens, install the light integrator and set the analyzer's switch to CYAN. Install the red filter on top of the light integrator and adjust the lens aperture until the meter indicates null. Switch the analyzer to MAGENTA, install the green-reading filter and note the meter reading. If it is not at null, add or remove magenta filters (from the filter pack) until the meter shows a null. Then switch the analyzer to YELLOW, install the blue-reading filter and

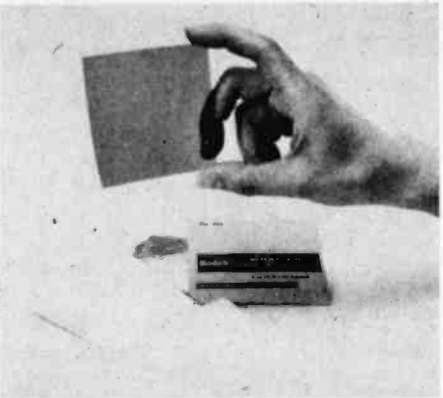


The basic color analyzer. Once controls are matched to a "standard" negative, just select filters for a null on the meter for each individual color and white.

modify the yellow filtration in the filter pack until the meter shows a null. Finally, set the analyzer to WHITE, remove all reading filters and adjust the lens aperture for a null indication.

Through the color analyzer you have now established a new filter pack and exposure for the new negative. If the new negative uses similar lighting to the reference negative the print should be perfect. If the lighting was considerably different the print will be good—acceptable to most people, but requiring just a slight filter pack modification for a great print.

Swinging Filters. In the previous example the filter pack would wind up with magenta and yellow filters—which is what is generally needed. Some Kodacolor negatives, however, might require cyan lters plus magenta *or* yellow (but never all three). This information will have been programmed into the color analyzer, so you will have no difficulty if you make a slight modification in procedure. The first meter reading, the one where you adjust the lens's aperture, should be made for the filter you are *not* using in the filter pack. For example, if your basic filter pack has cyan and magenta, switch the analyzer to YELLOW, place the blue-reading filter in position on the light integrator, and close down the lens for a null indication. Then proceed with the other readings. If your reference negative did not require cyan in the filter pack, if it had yellow, magenta, or both, and you find a new negative just can't be pulled in for null meter readings with yellow and magenta filters, it indicates the new negative requires cyan filtration, so start with the assumption that yellow is not



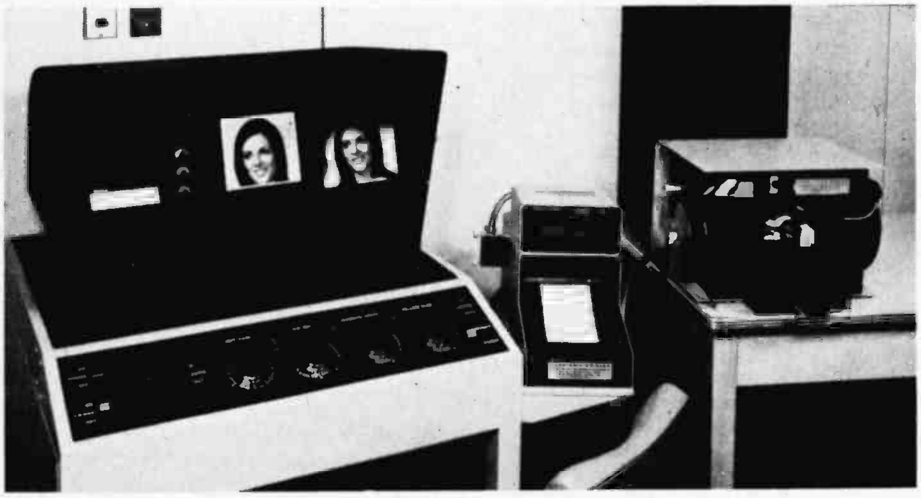
Kodak color printing filters. Typical filter designation CP20Y means color filter with a .20 density; the color is yellow.

required. If you still can't null the meter, it means magenta should *not* be in the filter pack.

As we mentioned, a more thorough discussion and procedure for using a color analyzer is found in Kodak's *Printing Color Negatives*.

Most, but not all, commercial color analyzers use photomultiplier tubes which have no light memory, nor are they confused by infrared from the enlarger lamp. These units are, as you would expect, relatively expensive. Low cost models use photoresistors.

More Data. Photoresistors are infrared-sensitive and they have a light memory, both of which can confuse the meter. The infrared is easily handled by installing a heat or infrared filter glass in your enlarger (it should be there to protect the negative anyway). The light memory is handled by using a consistent measurement procedure. The best way is to turn the enlarger off, install the reading filter and the light integrator, turn off the bright room lights, count to five, and then turn the enlarger *on*.



Professional equipment used by color labs includes this Kodak Video Color Negative Analyzer. It uses a 5-in. color TV screen to assist an operator in selecting the correct filter.

Take the meter reading, or adjust the appropriate color control, slide the new reading filter in place before withdrawing the old one, switch the analyzer, and make the new meter reading. Repeat this for the third reading filter. You'll note that this procedure keeps bright white light from falling on the photocell between meter readings. If you want to change filters under room lights, make certain there are about five seconds of darkness between turning the room lights out and turning the enlarger on.

The whole bit might sound somewhat complicated, but after you've run through the procedure once or twice to get the hang of things it shouldn't take you more than a minute or so for a full color analysis of a new negative.

The Kodak Wratten filters needed are available from professional camera shops. For the construction project, color analyzer 2-in. or 3-in. Kodak Wratten filters Nos. 98 (blue), 99 (green), and 70 (red) are recommended. If you have difficulty obtaining these specific filters you can make the following substitutions, through the analyzer's precision will be slightly reduced: 47B (blue), 61 (green), and 92 (red).

The Pro Shop. We could not close without some words on commercially processed color prints such as you might order from a drugstore or camera shop. Commercial color labs have as high (if not higher) a remake rate than the amateur if *quality* color prints are desired. As a general rule, it takes two tries to get a decent color print, so the hobbyist with a color analyzer is way ahead of the game because he can turn out, at worst, two *good* prints for each three first tries. The average is even higher than this as the hobbyist gets skilled in the use of a color analyzer.

Commercial labs come close to a hobbyist's results only when they are equipped with a video analyzer such as the Kodak Video Color Negative Analyzer Model 1-K; and Kodak only claims a 75%+ first try acceptance rate for their analyzer. The video analyzer is a 5-in. x 5-in. TV display. The operator views the color negative as a positive color TV image, and adjusts the TV's controls for proper color balance and brightness (saturation). The control settings are translated to the printing equipment's filter adjustments so that the final print is similar to the image displayed on the TV.

The video analyzer is a fast and easy way to get good color prints on the first try, but since video analyzers cost in the thousands, the color analyzer is the best thing going for the hobbyist. ■

Build this long range microphone and...

Bug Mother Nature

by F. J. Bauer

With a parabolic mike offering sonic and electronic amplification you're in tune with Helix Aspera to Yellow-bellied Sapsuckers!

ENGLISHMAN George Riley lives in Kent, works in London, and goes home to an unusual hobby.

"It all started about a couple of years ago when I borrowed a friend's parabolic directional microphone dish. This type of equipment is hyper-sensitive and can be pinpointed to record a sound without external noise interference. I was using it to record the sound of crickets when I suddenly heard a strange 'slurping crunching' sound. This turned out to be a large snail making the most of some hard grass. From then on I was hooked," says George.

Experts such as zoologist Donald J. Borror have used the parabolic microphone technique to produce 33⅓ rpm records that sonically illustrate ornithology books and booklets.*

After stumbling over a couple of radar antenna dishes a few years ago, I finally decided to put one of them to work. Since I was no microwave expert, I decided to try an acoustic application. After all, I reasoned, a parabolic dish is a parabolic dish whether it is used for reflecting and focusing microwaves or sound waves. The result is the parabolic microphone described in this article.

If you want to go all out for added gain, look over the surplus dealers' list for an 18-inch or larger aluminum model. As nearly as I can tell with the test equipment available, the 18-inch reflector adds about 10-dB gain to the microphone.

Construction. It's simple enough as reference to the photos will reveal. The mount for the dish is made of wood and masonite. The dish is held in place by three threaded rods which also serve as the microphone support. Almost any kind of rod material will do, as long as it is or can be threaded. I happened to have some odd pieces of 9-gauge aluminum clothesline which threaded easily with a 10-32 die. Make the rod length about 7½ inches to allow sufficient leeway for adjusting the microphone for optimum focus. A small bracket or block may be added where the dish touches the wooden base to add rigidity, and a hole in the center of the base will make it convenient to mount the whole assembly on a camera tripod.

Any low-priced ceramic or crystal microphone cartridge will work well with this reflector. The one shown in the photograph happens to be out of a pre-WW II hearing aid!

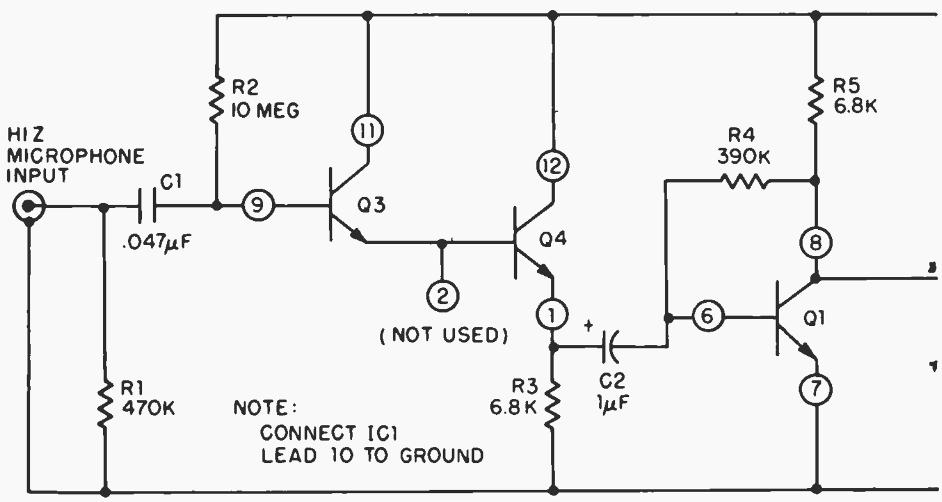
Mount the microphone cartridge on the rods with rubber bands. The exact method of attaching the rubber bands to the microphone cartridge is left to the ingenuity of the builder, since this will largely depend upon the physical configuration of the microphone.

Next route a 16-inch piece of shielded microphone cable from the microphone along one of the rods, through the dish (but inside the back plate), and terminate the cable in a phono plug. The cable should have sufficient slack so that it may be easily plugged into the amplifier box. Also, be sure to allow sufficient lead slack at the microphone end of the cable so that the shock mount effect of the rubber bands is not nullified. This will complete the microphone reflector assembly, which should be set aside until the amplifier is built.

Electronics. The amplifier is a three stage affair using an RCA CA3018 integrated circuit. Transistors Q3 and Q4 are used as a Darlington pair in an emitter-follower circuit in the first stage. This provides the necessary high input impedance required by the crystal microphone. The two following stages utilize Q1 and Q2 respectively as conventional common emitter amplifiers. The average gain per stage is about 38 dB.

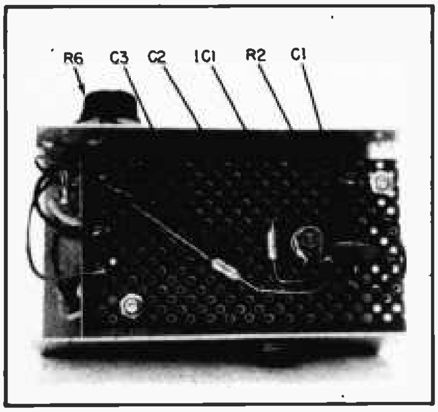
Capacitor C4 across audio gain control R6 provides a 3-dB roll-off at 15 kHz, thus limiting amplifier frequency response to the desired audio range. In addition to limiting the frequency response, this capacitor also reduces the tendency of the amplifier to oscillate at higher frequencies, which could result in instability and low output. The 3-dB point at the low frequency end is about 70 Hz, sufficient for this application.

Two 9-volt transistor batteries are used to power the amplifier; not because of high current drain, but, to avoid common coupling between the output stage

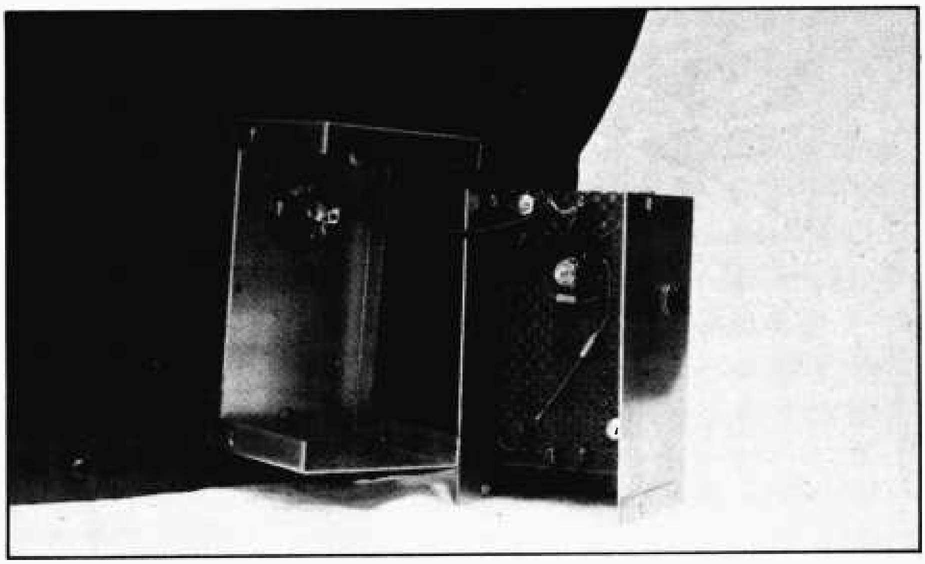


PARTS LIST FOR A PARABOLIC MICROPHONE

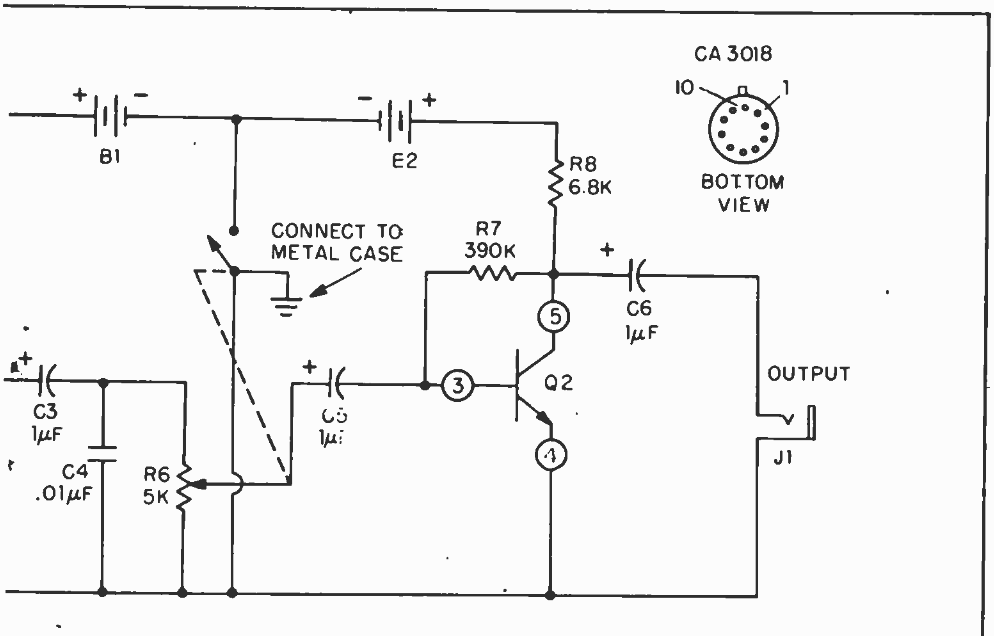
B1, B2—2U6-type 9-volt battery
C1—0.047-uF disc or tubular capacitor
C2, C3, C5, C6—1-uF electrolytic (observe polarity) or tubular capacitor, 35 volts or better
C4—0.01-uF ceramic disc capacitor
IC1—3018 integrated circuit (RCA CA3018), available from Circuit Specialists Co., Box 3047 Scottsdale, AZ 85257; $2.00 postpaid
R1—470,000-ohm, ¼-watt resistor
R2—10-megohm, ½-watt resistor
R3, R5, R8—6800-ohm, ¼-watt resistor



Place components above and below the raised perf board. High impedance circuit makes it necessary to shield the amp in a metal box.



Suspend the microphone you use from rubber bands that extend to the support rods. Or, a clamp wrapped in foam packing material holds Riley's microphone securely.



R4, R7—390,000-ohm, ¼-watt resistor
R6—5,000-ohm audio taper potentiometer with spst switch
Misc.—Aluminum case, 2 x 4-in. perf board, plugs, jacks, hardware, push-in terminals, microphone (high impedance crystal, see text), wire, solder, etc.
Note: The ETCO catalog lists a "government surplus" aluminum parabolic reflector. ETCO Electronics, 464 McGill Street, Montreal 125, Canada.

and earlier stages of the amplifier. An RC decoupling network could, of course, be used instead of two batteries, but it was found that oscillation would occur in spite of the decoupling network after the batteries had been in service for awhile. Two batteries absolutely guarantee against amplifier instability during the useful life of the batteries. The total current drain of the amplifier, by the way, is only 1.5 mA.

No trouble should be experienced with the amplifier if the original layout is followed. All amplifier components are mounted and wired on the perf board as shown. The volume control, capacitor C4, and the earphone jack are mounted on the part of the minibox that serves as a cover and battery holder. All connecting wires are soldered to push-in terminals on the perf board, and the perf board is mounted above the batteries with small bolts and spacers. After assembly, connect the microphone to the amplifier input with a short piece of cable.

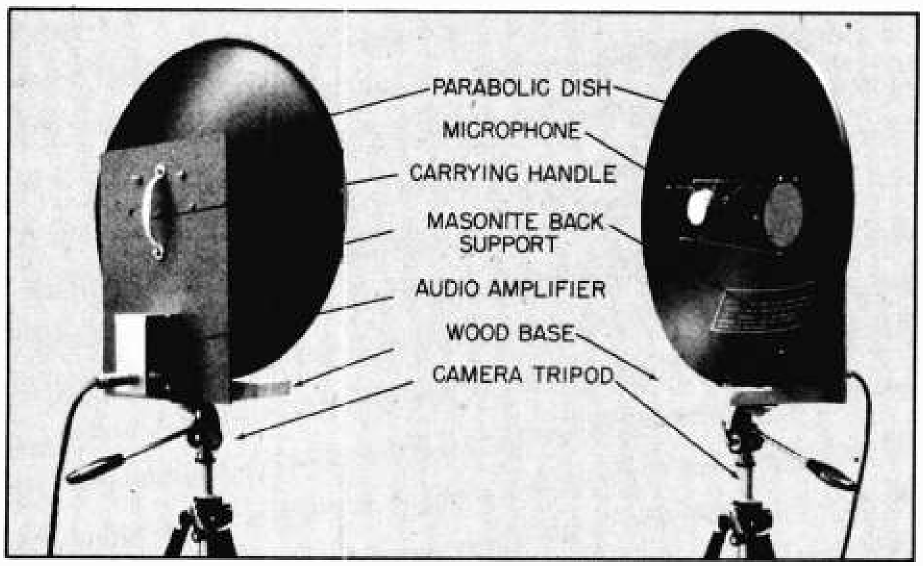
Check Out. When testing the amplifier on the bench, either have the microphone connected to the input terminals or substitute a half-megohm resistor for the microphone input. If you have a hum problem it is probably caused by nearby AC wiring. (I had to turn off power to the workbench whenever I tested the amplifier out of its case.) Alternatively, you may find a place in the house that is hum free; make your tests there. With the amplifier completely enclosed in its case, there is absolutely no hum pickup problem.

When you are satisfied that the amplifier is stable and working properly, solder the short microphone cable to the input terminals and mount the amplifier in its case. You are now ready to set up the microphone for maximum gain. To do this, you will need a code practice oscillator or other source of audio signal and an AC voltmeter with a ten-volt range connected to the amplifier output.

Set the equipment up in a clear area. Enable the CPA and adjust the audio gain so that the voltmeter reads two volts or less. Next move the microphone cartridge towards and away from the center of the dish to find the microphone position giving the greatest output. Do not let the voltmeter reading go above three volts because overloading the amplifier will make it difficult to find the point of maximum gain. After finding the best position for the microphone, secure the rubber bands on the support rods with dabs of cement.

The parabolic snooper may be used in several ways. As a portable field instrument, just plug in a set of 2000-ohm earphones and be on your way through the woods. The unit will also work as a combination microphone-preamplifier with any amplifier or tape recorder. However, if you are using a speaker for monitoring outside noises, be sure to have sufficient acoustic isolation between the microphone and speaker, such as closed doors and windows. If you don't, all the world will know by your feedback howl that you are listening. When using the unit with an audio power amplifier it is best to run the gain quite high on the amplifier and adjust the system gain as needed with the preamp gain control.

Now you're ready for a new world of close-up sound. ■



The audio amplifier cabinet cover is secured to the Masonite back support permitting snap removal of amplifier chassis for inspection.

****Common Bird Songs*, the title of a booklet and record by Borror, is available from Dover Publications, 180 Varick Street, New York 10014 for $3.50 postpaid; order number 21829-5. It provides songs of sixty species such as the Robin, Cardinal, Bluejay, Bobolink, and Tufted Titmouse!**

BATTERY MONITOR & CELL CONDITION TESTER

by Charles Green

Electro-chemical action tests your car battery!

ARE YOU ONE OF THE many who are servicing his own car? It pays to make sure that the battery is in good shape to prevent that slow, grinding start when you are in a big hurry. Just adding water at intervals isn't always enough to ensure that the battery will be in top condition when you need it.

With our expanded-scale battery tester you can make periodic tests of your battery to insure that the battery is in good shape. The tester is built in a compact plastic cabinet and includes easy-to-make special probes for the cell electrolytic tests as well as overall battery voltage tests. The construction of the tester is simplified for ease in building.

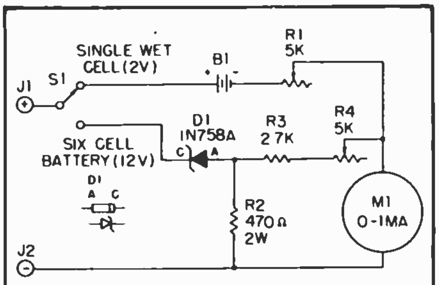
Tester Circuit. When S1 is set to the "single wet cell" position and voltage is at J1 and J2 (from the test leads), M1 will indicate only when the test voltage at J1 and J2 is higher in value than 1.4-volt battery B1. For example, if the test voltage is 1 volt (positive polarity at J1 and negative polarity connected to J2), the meter will not indicate since the B1 voltage is 1.4 volts. When the test voltage is 1.5 volts, there is a 0.1 volt difference over that of B1, and M1 will indicate a current flow (voltage) in the circuit. The 1.4-volt meter scale marking is equivalent to meter zero.

When S1 is set to the "six cell battery" position, zener diode D1 operates similarly to battery B1 in the other position. Since D1 is a 10-volt zener diode, a test voltage higher than 10 volts is required to allow M1 to indicate voltage.

Potentiometer R1 is the calibration pot for the *single wet cell* meter circuit, and R4 is the calibration adjustment for the *six cell battery circuit.* Series resistor R2 provides a minimum current flow through the zener so that it will operate properly.

Construction. The Tester is built in a 6 x 3½ x ⅞-in. plastic box with a plastic panel. The box dimensions are not critical, and any convenient size can be used. To minimize possible electrical short circuit hazards, do not use a metal box. Most of the components, are installed with push-in clips on a 3 x 2½-in. perf board with remaining parts mounted on the box panel.

The best way to start construction is

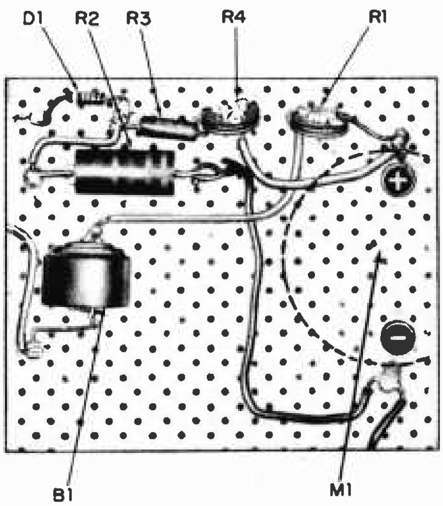


PARTS LIST FOR BATTERY MONITOR & CELL CONDITION TESTER

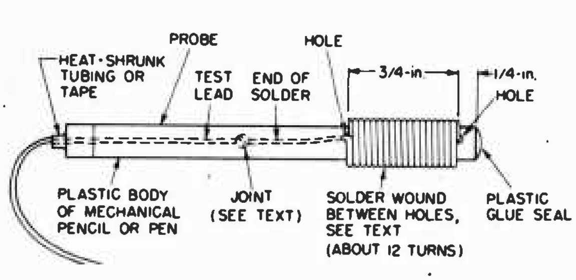
- **B1**—1.4-volt mercury cell, Eveready E640
- **D1**—10-volt, ½-watt zener diode (1N758A or HEP Z0220 or equiv.)
- **J1, J2**—binding posts; red, black
- **M1**—1-mA DC meter
- **R1, R4**—5,000-ohm miniature potentiometer
- **R2**—470-ohm, 2-watt resistor
- **R3**—2,700-ohm, ½-watt resistor
- **S1**—spdt rotary or toggle switch
- **Misc.**—plastic chassis box and panel 6 x 3½ x 1⅞-in. (approx.), perf board, push-in clips, plastic mechanical pencils and solder for test probes (see text), wire, etc.

to cut out the M1 mounting hole in the panel and install the meter in approximately the same position shown in the panel photo. Then locate and mount S1, J1 and J2. Cut a section of perf board to size, and drill two holes to fit the M1 terminal screws to mount the board. Install the perf board to the meter terminals with two solder lugs supplied with the meter.

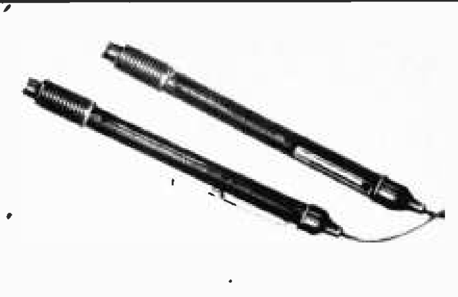
Mount the board components with push-in clips at the approximate locations shown in the board photo. Use short leads for best mechanical rigidity, and wire as shown in the schematic. Make sure that D1 and B1 are connected with the proper polarities as



Perf board showing components including location of meter as dashed line. Mercury cell battery will last its shelf life, which is generally two years for a fresh battery. Eliminate D1, R2, R3, R4, and S1 for a dunk-test only meter. 2-V is center scale.



Use the plastic body of a mechanical pencil or modify a set of old VOM leads. Either way, wrap 10 to 18 turns of "wire" solder around the end to serve as the electrolyte contact surface. Shrink tubing makes a neat job. Connect the wire lead and the solder together before trying to put the lead into the hole.



shown in the schematic. Carefully solder B1 to the push-in clips with a minimum of heat, or the mercury cell may be destroyed. If desired, you can use commercial mounting clips for the battery that do not require soldering.

Wire the remainder of the tester circuits and the panel components. Carefully check the wiring and make sure that M1 is connected with the proper polarity.

Test Probe. The tester requires special probes for the electrolyte test. As shown in the drawing, the probes are made from solder wrapped around the end of a plastic tube (we used a plastic body of a mechanical pencil and #18 60/40 rosin core solder).

Begin construction by selecting a pair of mechanical pencils with black and red plastic bodies for your test leads. Carefully cut off the metal pointed end of each pencil and remove the entire mechanical assembly from inside the pencil. Clean out the inside of the pencils so they are completely hollow and have no inside obstructions.

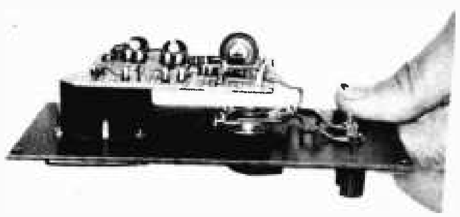
Drill two holes spaced ¾-in. apart approximately ¼-in. from the end of each pencil body, and wrap wire solder between the holes as shown. Insert the ends of the wire solder into the holes to hold the turns in place. The end of the wire solder in the hole toward the other end of the pencil body (the former eraser end) should be long enough to reach through the body end to be carefully soldered onto the test lead. Then carefully push the solder back into the plastic body with a portion of the test lead. Do not try to stretch the wire solder or use too much tension or the solder will break. Carefully insert short plastic sections into the body end to wedge the test lead in place and prevent it from being pulled out, then tape or use heat-shrink plastic tubing on the lead end of both test probes. We used hot plastic from an electric glue gun to seal up the open end of the test prod and at the places where the solder is fed into the holes. Do not put any hot plastic over the solder turns.

Calibration. If you have a 1-mA meter for M1 of the same size scale as in our model, and the same type of zener diode specified, you can copy the photo of the meter scale and cement it over the meter scale of your meter. Set S1 to the *single wet cell* (2 volt) range and connect the tester to an exact source of 2 volts DC. Adjust R1 for an M1 indication of 2 volts (at center scale). Then set S1 to the *six cell battery* (12 volt) range. Adjust R4 for a 12-volt center scale indication with exactly 12-volts input to the tester. Make sure that you have connected the right polarity input for these calibration adjustments (J1 connected to positive (+) voltage and J2 connected to negative (−) voltage terminals).

For a more accurate meter calibration (and if you are using a different size 1 mA meter or a different type of 10-volt zener diode) you will need a calibrated variable voltage DC power supply or a DC supply with a potentiometer and a monitor voltmeter. Calibrate both ranges of the tester by adjusting R1 and R4 for midscale indications as in the previous (cemented meter scale) procedure, and then marking the meter scales in accordance with the calibrated DC power supply or the monitor voltmeter. Our model was calibrated from 1.4 to 2.6 volts on the 2-volt range of S1, and from 10 to 14 volts on the 12-volt range.

Operation. Automobile storage batteries consist of a number of 2-volt cells connected in series—three cells for a 6-volt battery and six cells for a 12-volt battery. As shown in the drawing, the tester probes are inserted into the electrolytic filler holes of a pair of *adjacent* (series-connected) cells so that the tester will indicate the voltage between the electrolytes in each cell. This voltage is approximately 2 volts, depending on the condition of the battery cells. The test will show the condition of *the positive plate* in one cell and *the negative plate* in the paired cell. By making tests of each pair of cells along the battery, the overall condition of the battery can be determined. Make sure that you observe proper test probe polarities.

If you are not sure which cell is the correct mate of another cell (since the arrangement of cells under the plastic top of the battery cannot be seen), momentarily place the probe into the electrolyte of a cell and quickly withdraw the probe if the meter (M1) swings sharply upscale, indicating overvoltage. The ¼-in. plastic section at the end of the probes should minimize the possibility of shorting out the cell between the plates, but use care in placing the probes into the battery holes; hold them in your hands—do not just drop them into the electrolyte while taking readings. Place the probes just far enough into the electrolyte to obtain an M1 indication. The probe electrodes may have slight tendency to polarize (act like little miniature storage batteries due to electrochemical action on the solder) and affect the meter indication. To prevent this, slightly agitate the probes in the electrolyte while testing.



Inside the meter. Mount perf board to meter using screws in meter terminals. Solder leads to battery B1 terminals directly or use a battery clip.

Test your storage battery at periodic intervals and note the cell readings. This will give you a performance record to check when you suspect that the battery may be defective. When a battery starts to go bad, it will show up as widely different voltages between cells (usually one cell will start to go bad before the others—not all the cells at once). For best results, make your periodic tests when the battery is in approximately the same electrical state of charge; the battery should be fully charged and have stabilized for some time before making tests. The probes should be washed and dried after each use to prevent corrosion from affecting the readings. The 12-volt scale of the tester can be used with a normal set of test probes to periodically check full battery voltage across the battery terminals. ■

SUPER DXER

Our outboard rig makes QSL waves—adds 20dB minimum gain to any shortwave receiver

CAN YOU REMEMBER the early days of TV—back to the mid- and late-1940s—when the Joneses, who had the only TV in the neighborhood, would strain to clean up a snowy, flickering picture by adjusting a "booster" that sat on the top of their 12-in. phosphor cyclops?

Well, more often than not those outboard boxes, with their 6J6s in push-pull tunable circuits, didn't amount to the proverbial hill-of-beans. Those World War II vintage tubes were not at all well suited to the new-fangled wide-band requirements of TV. But later on as the technology advanced, and more powerful transmitters were built, good, solid pictures became the rule.

Unlike the old TV boosters, today a good booster for short wave receivers—a preselector—can be designed with all the advantages of the latest solid-state devices; and, to boot, it can be simple and very easy to build. It's the easiest way to turn any receiver into an even hotter signal sniffer. You use a booster (a very high gain RF amplifier) between the antenna and the receiver antenna terminals. A good one will also provide sharp image rejection by adding a relatively high-Q circuit to the receiver input. Image signals (which often take the pleasure out of receivers with low frequency single-conversion IF amplifiers by jamming desired signals) vanish as if by magic when passed through a high-Q booster or preselector. In short, a top quality super booster such as the SUPER DXER, will add another dimension of performance to any shortwave receiver.

What It Can Do. The SUPER DXER provides from 20 to 40 dB of signal boost—the exact amount is determined by the particular input characteristics of your receiver. Figuring on 6 dB per S-unit, that's an increase of better than 3 to 6 S-units. In plain terms, the SUPER DXER will bring in stations where all your receiver will pick up running barefoot is its own noise.

The SUPER DXER's input is a diode protected FET (field effect transistor); the protection diodes are built into the FET so that excessively strong input signals, and even static discharges, will not destroy Q1. Since the FET's input impedance is many thousands of megohms, there is virtually no loading of the L1/C1 tuning circuit; its "Q" remains high and provides a very high degree of image-signal attenuation.

The SUPER DXER output circuit is a low impedance emitter follower, and it will match, with a reasonable degree of performance, just about any receiver input impedance. As long as your receiever has two antenna terminals, one "hot" and one ground, you can use the SUPER DXER.

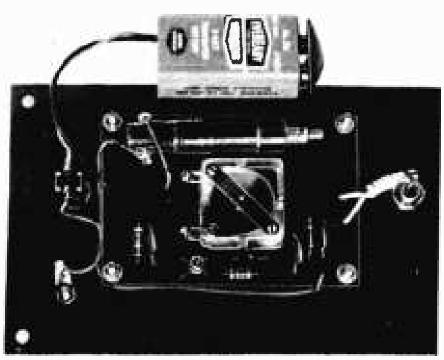
Optimum performance will be obtained if your receiver is equipped with an antenna trimmer. Just as the antenna trimmer peaks the receiver for use with any type of antenna, it also adds something extra when matching the SUPER DXER.

Set Bandpass. The SUPER DXER has a tuning range of slightly more than 3-to-1 between 5 and 21 MHz. That means if the low end is set to 5 MHz, the upper limit will be slightly higher than 15 MHz (3 times 5). If the lower limit is set at 7 MHz, the upper frequency limit will be slightly higher than 21 MHz. Since the slug in tuning coil L1 is adjustable, you can select any operating range between 5 and 21 MHz.

SUPER DXER, though a very high gain device, is absolutely stable if built exactly as shown and described. There will be no spurious oscillations or response. It is possible that changes in the component layout or construction will result in self-oscillation at certain frequencies; hence, make no modifications or substitutions unless you are qualified.

Getting Started. Your first step is to prepare the printed circuit board. Using steel wool and a strong household cleanser such as Ajax or Comet, thoroughly scrub the copper surface of a 2¼-in. x 3¼-in. copper-clad board. Any type will do—epoxy or fiberglass; the type of board is unimportant. Rinse the board under running water and dry thoroughly.

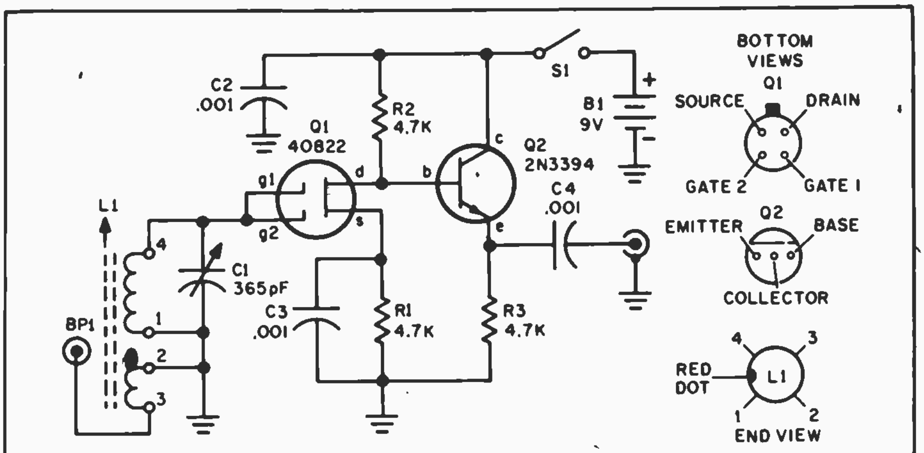
Cover the copper with a piece of carbon paper—carbon side against the



Add an extra 20+ dB gain to your shortwave receiver. Simple kit-of-parts is available. You supply the outer case and knob. Note: Wrap J1 ground wire as shown above.

copper—and place under the full-scale template we have provided. Secure the PC board in position with masking tape. Using a sharp pointed tool such as an ice pick, indent the copper foil at each component mounting hole by pressing the point of the tool through the template and carbon paper. Next, using a ball point pen and firm pressure, trace the foil outlines on the template.

After all foil outlines have been traced, remove the PC board from under the template and, using a resist pen, fill in all the desired copper foil areas with resist. Make certain you place a dot of resist over the indents at each of the corner mounting holes. Pour about one inch of etchant into a small container and float the PC board—copper foil down—on top of the etchant. Every five minutes or so gently rock the container to agitate the etchant. After 15 or twenty minutes check the PC board to see if all the undesired copper has been removed. When every trace of the undesired copper is gone, rinse the board under running water, and then remove the resist with steel wool or a resist "stripper."



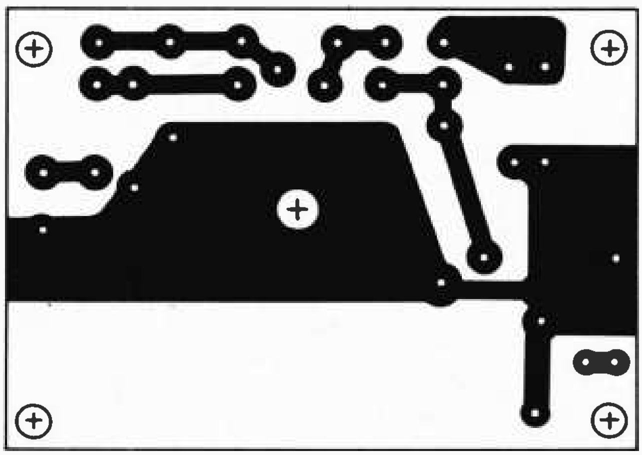
PARTS LIST FOR SUPER DXER

B1—9-volt battery (Eveready 216 or equal) and connector
BP1—insulated binding post
C1—365-pF subminiature tuning capacitor
C2, C3, C4—0.001-uF, 25-VDC or better ceramic disc
J1—RCA-type phono jack
L1—5 to 20-MHz antenna coil, Custom Components SW-520
Q1—MOSFET, RCA 40822
Q2—npn transistor, 2N3394
R1, R2, R3—4700-ohm, ½-watt resistor
S1—spst switch (power on-off)

A kit of all the above components including the printed circuit board is available from the Electronic Hobby Shop, Box 192, Brooklyn, N.Y. 11235. Price of $24.50 includes postage. New York State residents must add sales tax. No foreign orders. Allow 6-8 weeks for delivery. Postal Money Order speeds delivery.

Continue. Drill out all the mounting holes marked by an indent with a #57, 58, or 59 bit—this includes the corner mounting and C1 mounting holes. Then drill the corner mounting holes for a #6 screw, and use a 5/16-in. bit for the C1 mounting hole.

Install tuning capacitor C1 first. Tuning capacitor C1 should be the type provided in the kit of parts. It has a plastic dust cover and a long shaft. Do not use the type supplied with a short shaft to which a tuning dial for the broadcast band can be attached. Remove the mounting nut and ground washer from C1's shaft. Then make certain the shaft's retaining nut is tight. It is usually supplied loose. Discard the ground washer and secure C1 to the PC board with the mounting nut. Then install tuning coil L1. Make note of two things about L1: the terminal end of L1 has a large *red* dot (ignore any other marks); L1 must be positioned so the red dot faces the bottom edge of the PC board—the edge closest to the coil. Also note that the lug connected to the top of the fine-wire primary is adjacent to the bottom of the heavy-wire secondary. When the red dot is facing the edge of the PC board, both these lugs are against the board. Solder the lugs to the matching holes in the PC board. Use the shortest possible length of wire to connect the remaining primary (fine-wire) terminal to the antenna input printed foil. Connect the remaining L1 terminal (heavy wire) to its matching hole with solid, insulated wire—form a right angle bend in the wire so it doesn't touch L1. Now mount the remaining components.



Exact PC board size. Transfer image to copper-clad board using carbon paper. This is the bottom (copper) side of your board. Mount it to the front panel with ¼-in. spacers between board and panel at each mounting screw. Secure the battery to the back of the cabinet with tape.

Orienting Q. Note that Q1 is positioned properly when the small tab on the case faces the nearest edge of the PC board. Also note that the round edge of Q2 faces the nearest edge of the PC board. The flat edge of Q2's case should face C1.

Because the printed copper foil faces the front panel when the assembly is mounted in the case, and is therefore inaccessible for soldering, the connecting wires to front panel components should be installed at this time. Solder 6-in. solid, insulated wires to the antenna, output, and output ground, and +9V foils. Solder the negative (usually black) wire from the battery connector to the ground foil.

The Super DXer is mounted in a standard plastic or Bakelite case approximately 6⅜-in. x 3 3/16 -in. x 1⅞-

SUPER DXer

in. The front panel must be aluminum. If the cabinet is not supplied with an aluminum panel, obtain an optional or accessory metal panel. Do not use a plastic panel.

Drill a ⅜-in. hole in the center of the front panel. Position the PC assembly over the hole with C1's shaft fully inserted through the hole, and mark the locations for the four PC board mounting screws. Drill the panel and temporarily secure the PC board to the panel. Then locate the positions for power switch S1, antenna input binding post BP1, and output jack J1. Make certain J1 is as close to the PC board output terminals as is possible—within 1½ inches.

Remove the PC board and drill the holes for the panel components. Power switch S1 can be any inexpensive spst type such as a slide switch. Install the panel components and then the PC board. To prevent the copper foil on the underside of the PC board from shorting to the panel, place a ⅜-in. plastic or metal spacer, or a stack of washers, between the PC board and the panel at each mounting screw. Connect the panel components to the appropriate wires extending from the PC board and the SUPER DXER is ready for alignment.

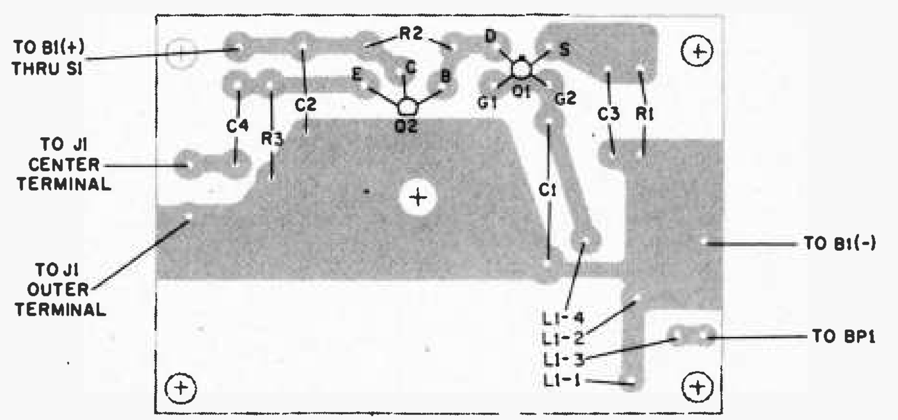
Alignment. Prepare a length of 50 or 52-ohm coaxial cable (such as RG-58) that will reach from the SUPER DXER's output jack to the receiver antenna input terminals. Solder a standard phono plug to one end. Take care that you do not use ordinary, shielded cable such as used to interconnect hi-fi equipment; coaxial cable is a must.

Connect the coax between the SUPER DXER and your receiver. Rotate the C1 shaft fully counterclockwise and install a pointer knob so that the pointer extends to the left (9 o'clock position). Connect your antenna to binding post BP1. Then, set L1's slug so that the *bottom* of the screwdriver slot is level with the very *top* of L1. This will provide a frequency range of approximately 5 to 15 MHz. If you back out the slug ¼ inch, the frequency coverage will be from approximately 7 to 21 MHz. You can use any in-between slug adjustment.

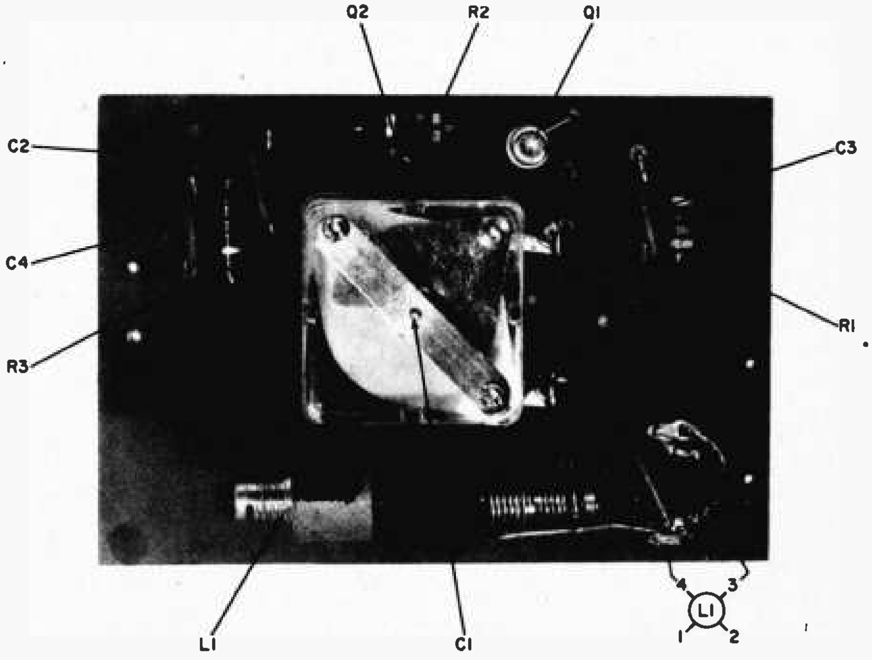
Turn on the receiver and booster, and set the receiver tuning to 5 MHz, or whatever frequency you selected for the "bottom end." Adjust C1 for maximum received signal or noise and mark the panel accordingly. Repeat the procedure at approximately 7, 10, 14, and 15 (or 20) HMz. The panel markings are important because the SUPER DXER's tuning is so sharp it must be preset to near the desired frequency or you'll receive nothing—neither signal nor noise. The panel markings complete the adjustments.

Pull 'em In. To prevent self-oscillation, you must keep the antenna wire as far as possible from the coaxial output cable. To receive a signal, set C1 to the approximate desired frequency and then tune in the signal on the receiver. Finally, peak C1's adjustment for maximum signal strength as indicated on your receiver's S-meter, or listen carefully for an increase in speaker volume. Keep in mind that, if the signal is sufficiently strong to begin with, the receiver AVC will "absorb" the SUPER DXER's boost, and the speaker volume will probably remain the same, though the S-meter reading will increase. SUPER DXER's boost will be most apparent on very weak signals, digging out those signals below the receiver's usual threshold sensitivity, making them perfectly readable.

Don't worry about strong signals overloading your SUPER DXER; it is virtually immune to overload even from excessively strong signals. However, the booster's output can be so high as to overload the input of some budget receivers. If this occurs simply reduce the booster's output by detuning C1 just enough to drop the overall signal strength below the receiver's overload value. Happy DXing! ■



For exact part placement on PC board, see diagram above. View is from component (top) side of your Super DXer board. Layout below shows a completed Super DXer. Pins 3 and 4 of the dual winding coil L1 are shown in an end view for clarity.



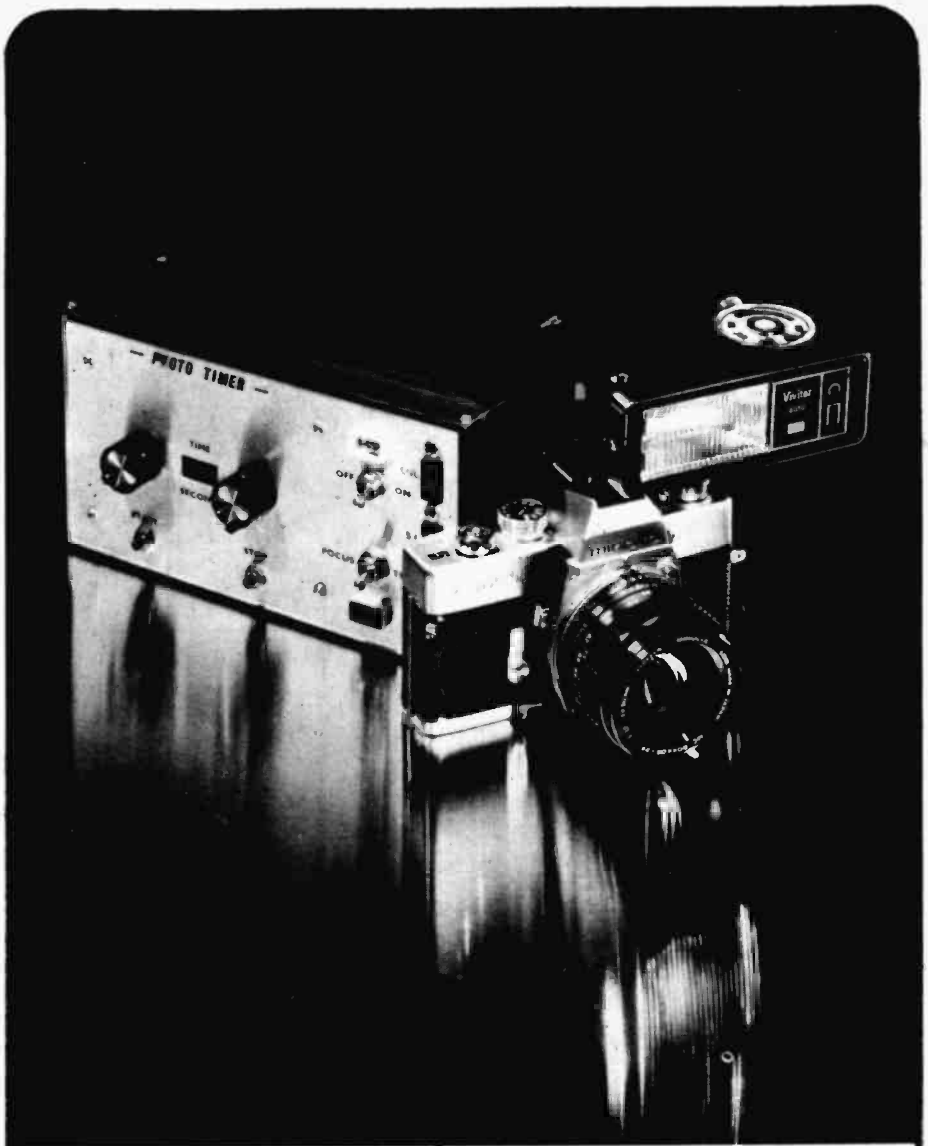


PHOTO TIMER

Designed for your creative difference by a darkroom craftsman. This precision tool does everything but turn off the lights!

by Adolph A. Mangieri

FEATURING illuminated digit-set dials, automatic reset, and safelight control, the PHOTO TIMER eliminates error-prone juggling of room light, safelight, and timer switches and dials. You can set the timer in complete darkness and you can be sure the safelight was off when you used your enlarger printmeter. The large easily-read dial indications make the timer a joy to use. The timer also includes push-to-start and push-to-stop buttons.

Using the 555 precision IC timer, the timer circuit is not affected by line voltage changes. Timing is adjustable from 1 to 119 seconds in one-second steps. Accuracy and repeatability depend only on the accuracy of the timing resistors and quality of the timing capacitor. The PHOTO TIMER is easily constructed at low cost.

Circuit Operation. The schematic diagram shows a 555 precision timer connected as a one-shot timer with automatic reset. The timing interval is determined by timing capacitor C1 and by timing resistors selected by switches S1 and S2. Assuming pin 5 of IC1 is disconnected from calibration pot R9, the time interval T (seconds) equals 1.1 times R (megohms) times C (microfarads). Timer-output at pin 3 controls both normally-off load relay K1 and normally-on load R6. If one load is de-energized, the other is energized and vice-versa.

With C1 initially held discharged by IC1, timing commences when start button S4 is depressed causing a triggering pulse at trigger pin 2. The relay closes instantly and C1 begins to charge through the timing resistor. When the voltage of C1 rises to two-thirds of the DC supply voltage, IC circuits are activated causing the relay to open and C1 to discharge completing the cycle with automatic reset. A timing cycle in progress may be terminated by depressing stop button S3.

Calibration pot R9 varies the timing control voltage at pin 5 accounting for tolerances of timing capacitor C1. Provided with both normally-on and normally-off loads, the IC circuit draws a

PHOTO TIMER

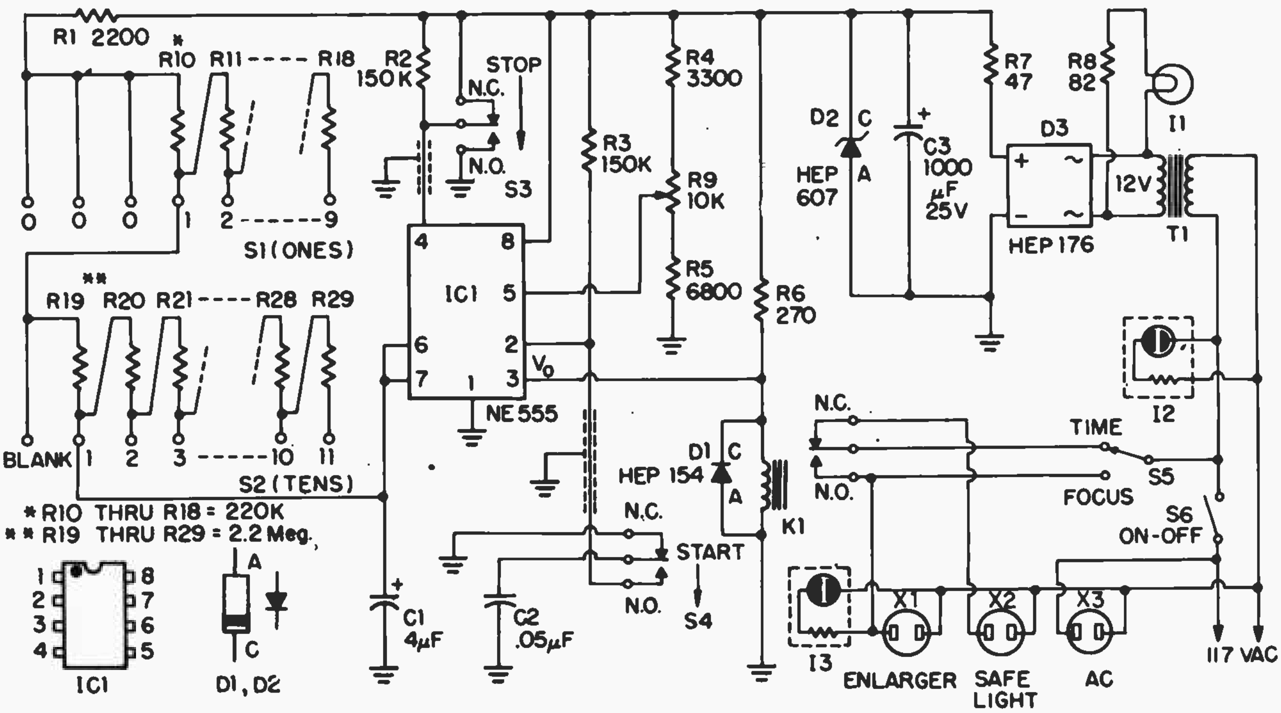
fixed load current from the power supply. Resister R7 sets the DC supply voltage to about thirteen volts. Voltage clamp zener diode D2 limits the supply voltage to safe values if the supply voltage should rise. Timing is not affected by changes in supply voltage. Rectifier diode D1 eliminates voltage spikes at K1 which would re-cycle the timer.

Construction. Build the PHOTO TIMER in a 9 x 5 x 3 in. metal cabinet. Begin construction by cutting out two 2½ in. dial discs from 1/16 in. thick red or white transluscent plastic. The discs are easily cut using a holesaw. Chuck the discs in a mandrel and true up the edges. Ream the center hole to clear the shafts of switches S1 and S2. Drill through a pair of small panel knobs and cement a knob to each disc using epoxy cement.

Drill suitably spaced (one disc diameter) slightly undersize holes in the panel and ream for a close fit for the shafts of the switches. Cut the perforated board to size and drill four holes for 6-32 x 2 in. spacer bolts which support the board behind the panel. Drill four matching holes in the panel, bolt the board directly against the panel, and locate and machine holes in the board to accept the switches. Cut out a ⅜ by ¾ in. window in the panel midway between the switch shaft holes. Complete machining of the panel and apply panel labelling and a clear protective coating.

Install switches S1 and S2 on the board, dial discs on the switch shafts, and trial mount the assembly on the panel. The dial discs should rotate with little wobble and no contact with the panel. If needed, enlarge a switch hole on the board to correct any disc tilt by shifting the switch slightly. Remove the circuit board assembly from the panel and affix the discs at the top end of the shafts. This simplifies application of dry transfer numerals at the edges of the discs while using the switches to index the disc for each position. Label the "ones" dial with three zeros and 1 through 9. Label the "tens" dial 1 through 11 leaving a blank space. You can remount the assembly on the panel and check and correct any badly aligned numerals.

Using 1/16 in. aluminum, make the compartment partition supporting trans-



PARTS LIST FOR PHOTO TIMER

C1—4-uF, mylar capacitor, 50-VDC (Cornell Dublier WMF or similar)
C2—0.05-uF, capacitor, 100-VDC or better
C3—1000-uF, electrolytic capacitor, 35-VDC or better
D1—1-amp, 50-volt silicon rectifier (HEP 154)
D2—15-volt, 1 watt zener diode (HEP 607)
D3—1-amp, 50 volt bridge rectifier
I1—see R8 note or #47 panel lamp
I2, I3—neon panel lamps
IC1—555-type integrated circuit
K1—dpdt relay, 12-volt DC, 3-amp contacts, coil resistance 350 ohms, coil current 50 mA. (Radio Shack 275-206 or equiv.)
R1—2200-ohm, ½-watt resistor
R2, R3—150,000-ohm, ½-watt resistor
R4—3300-ohm, ½-watt resistor
R5—6800-ohm, ½-watt resistor
R6—270-ohm, 1-watt resistor
R7—47-ohm, 1-watt resistor
R8—82-ohm, 3-watt ww resistor. Note—delete if 14 volt lamp such as #53 is substituted for I1.
R9—10,000-ohm trimpot
R10 to **R18**—220,000-ohm, ½-watt resistors, 5% or better
R19 to **R29**—2.2-megohm, ½-watt resistors, 5% or better
S1, S2—single-pole, 12-position switch, shorting type
S3, S4—spdt momentary pushbutton
S5—spdt toggle switch (FOCUS/TIME)
S6—spst toggle switch to match S5 (ON-OFF)
T1—miniature transformer, 117-VAC pri., 12-VAC sec, 300-mA
X1, X2, X3—AC chassis receptacles

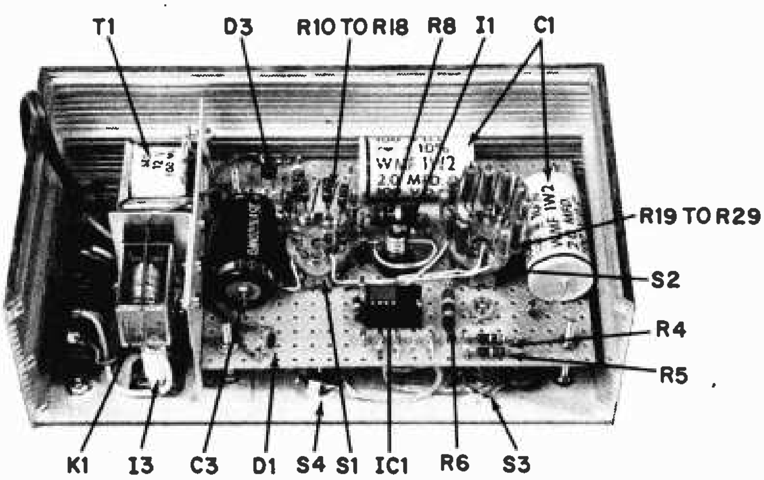
Misc.—panel knobs, case 8½ x 4½ x 3-in. (Vector W30-86-46), perf board, push-in terminals; translucent plastic sheet 1/16-in. thick for dial, small knobs, line cord, IC socket, spacer bolts (4), wire, solder, etc.

IC-design photo timer features backlighted digit-set dials, pushbutton start and stop buttons, and safeligfit control. Modern circuitry provides high accuracy and repeatability over the 1 to 119 second timing range. Home darkroom using our photo timer is equipped with Omega B color enlarger.

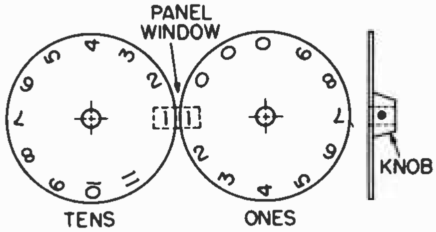
former T1 and relay K1. The partition is secured by two of the spacer bolts. Cut out a portion of the flange of the partition to avoid interference with the "ones" dial disc. Make a bracket to accept the socket of K1 and affix to the partition. Wire the AC sockets, neon panel lamps (supplied with external voltage dropping resistors), and toggle switches before installing T1 and K1. Wire the normally open poles of the DPDT relay in parallel to double the current rating.

Install a large rubber grommet on the circuit board directly behind the panel window to accept panel lamp I1. Tint the lamp with red transparent lacquer. Complete wiring of the board using a socket for IC1. Carefully observe polarities of D1, D2, and C3. Use shielded wire for connections to pushbuttons S3 and S4. Install resistors R10 through R29 directly on the switches. It's usually a simple operation to defeat the switch detent stops on S1 and S2 allowing continuous rotation of the dials. Set the switches to pick up R10 and R19 and position and secure the dial discs for 11 seconds readout.

Capacitor C1 should be a mylar, polycarbonate, or polystyrene low-leakage, low-loss type. C1 was made up by connecting two 2 uF capacitors in parallel but you can use a single 4 uF capacitor. You can use a 5 uF capacitor by changing R10 through R18 to 180,000 ohms and R19 through R29 to 1.8 megohms.



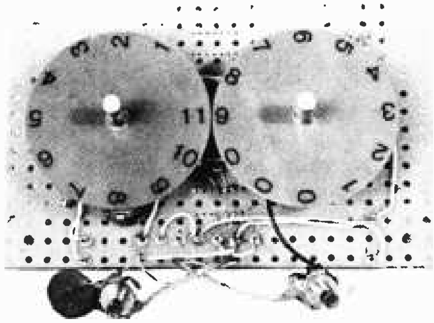
Major parts layout showing author's use of two 2-uF caps in parallel for C1.



Digit-set discs can be made at home from a plastic sheet. Press-type numerals can be used for neat job after cutting out the discs if you draw a temporary base line for each double digit and use it to align numbers.

Checkout And Calibration. Using a VOM, verify the presence of approximately thirteen volts DC across C1, about fifty milliamperes current in R7, and about five volts AC across lamp I1. If you have substituted for T1, it may be necessary to resize R7 and R8 accordingly. To calibrate the PHOTO TIMER, plug a sweep second electric clock into socket X1. Turn S6 on and set S5 to time. Set the dials for fifteen seconds. Depress start button S4 and observe elapsed time on the clock. By trial settings, set R9 so that the clock runs for fifteen seconds. Next, set the dials for 119 seconds and observe elapsed time. If you have used high quality capacitors for C1 the interval should check close to 119 seconds with

(Continued on page 98)



Dial discs are labeled 0 to 9 (units) and 1 to 11 (tens) with discs positioned at top of switch shafts while using the switches to index the discs. Illustration shows 119 seconds. This system allows resetting to the exact time within the resolution and accuracy of the system's electronic timer.

YOUR CB CAN TELL TIME

Tired of all those fancy experimenter projects good for everything but a CB shack? Here's a goof-proof project that puts SW broadcasts on a CB without modifications!

by Malcolm K. Smith

THE receiver in your CB transceiver is almost certainly an excellent signal grabber with good selectivity and sensitivity. But, it's crystal controlled to receive only the CB channels. There is, however, a simple way to make your CB serve as a high quality rig for VHF monitoring, short wave listening, checking the National Weather Service forecasts, or getting an accurate time and frequency signal. All you need is a simple device called a converter that requires no changes to the inside of your rig. And, best of all, building a converter is a breeze, because it can be made from low cost modules available in kit form.

There are many exciting signals you can receive on your CB with a converter, but the most useful ones are the precision time and frequency broadcasts sent out by CHU in Canada and the National Bureau of Standards station WWV in Fort Collins, Colorado. Let's say you've just built the e/e MAXICLOCK—a first class digital clock; surely you need something better than a DJ's idea of the time to set your clock. Or, if you're interested in accurate calibration of a receiver or transmitter, you need the precision standard frequency given by WWV. And now, if you'd like to tell time with your CB using a converter, what is a converter, and how does it work?

A converter mixes together an input signal—let's say CHU at 7.335 MHz—with a signal from a "local oscillator" (LO) in the converter itself. When two signals are mixed, out come new signals at the sum and difference of the original frequencies. Suppose you mix the 7.335 MHz signal from CHU with an LO signal of 19.730 MHz; one of the output signals is their sum—27.065 MHz, the frequency of channel 9.

Simplex Circuit. Take a look at the block diagram which is nearly the schematic of a converter; the 7.335 MHz signal is amplified by the RF amplifier and fed into the mixer where the LO signal (19.730 MHz) is added to it. The sum frequency (27.065 MHz) is fed into the antenna input jack of your CB (tuned to channel 9), and from the speaker you now hear the time signals. You have "converted" 7.335 MHz to 27.065 MHz!

Incidentally, the workings of CB receivers were well described in e/e for July-August 1974. If you have that issue, the article on page 45, "Discover Your CB Receiver," gives a good explanation of converters.

Our CB time converter uses three easy-to-build and low-in-cost modules available from the International Crystal Mfg. Co., 10 North Lee, Oklahoma City, Okla., 73102. Each module performs one function and consists of a transistor, a tuned "LC" circuit, and other components mounted on a printed circuit board. The three kits needed here are: SAX-1, the RF amplifier; MXX-1, the RF mixer; and OX, a crystal controlled local oscillator. You will have to buy an "EX" crystal for each frequency to be received unless you have one of the old tunable receivers such as the Lafayette Comstat 19, which can be manually tuned over a range of about 300 kHz. In that case, you would require only one crystal to cover this 300 kHz range.

Pinpoint Hertz. How do you calculate the required crystal frequency? First, determine the frequency you wish to

CB TIME CONVERTER

(Continued from page 70)

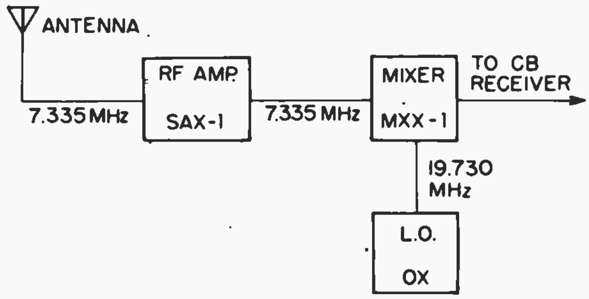
receive; let's say WWV on 10.0 MHz. This is a good first choice since WWV seems to come in well at most times. Next, decide on the channel to use; channel 9 is probably best, since there will be very few strong CB signals to leak through and interfere with the converter signal. The frequency of channel 9 is 27.065 MHz.

The next step depends on whether you are going to convert "up" or "down." Here you are converting up to a *higher frequency*, and so you *subtract* the desired frequency from the channel 9 frequency to get the LO frequency as follows—channel 9 frequency (27.065 MHz) minus the desired signal frequency (10.000 MHz) gives the "LO" frequency, 17.065 MHz.

Now suppose you want to receive a frequency higher than channel 9, say a National Weather Service Station on 162.55 MHz. Incidentally, NWS weather and many other VHF signals are frequency modulated (FM). Your CB rig is not designed to receive FM, but, surprisingly enough, it does a pretty good job (don't try, however, to build a converter for the FM broadcast band; your CB rig can't handle their large frequency shifts).

Here you get the LO frequency by subtracting the channel 9 frequency from the desired frequency, since this is "down" conversion, as follows—desired signal frequency (162.55 MHz) minus the channel 9 frequency (27.065 MHz) gives the "LO" frequency 135.485 MHz.

With three easy to construct and inexpensive kits, which come with an etched and drilled PC board, you can electronically "slide" your CB receiver down to pick-up short wave broadcasters like WWV, CHU, or even the Voice of America.



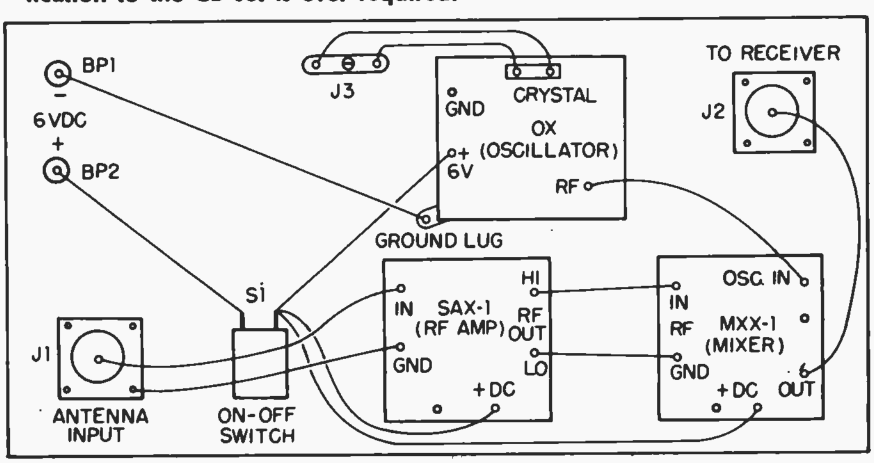
3-Way Cut. So, you want a crystal of frequency 135.485 MHz, right? Wrong! There is a slight complication in using the OX oscillator at frequencies over 60 MHz. You can't use the basic or fundamental frequency of the crystal. You have to use what are called its harmonics—frequencies which are two or three or more times the fundamental. Here you use the third harmonic—three times the fundamental. Therefore, the crystal frequency should be *one third* the LO frequency. The NWS crystal is, therefore, 135.485 ÷ 3 = 45.1617 MHz. The table gives crystal frequencies for a few other common signals.

In addition to the International Crystal modules and EX crystals, you'll also need a few small parts and a box or cabinet for mounting. The cabinet requirements are not critical; a small metal box or one with a metal cover should serve well. The common bakelite box with aluminum cover is fine. A box about 4 x 8 x 2½-in. is good because it gives you plenty of room for batteries, connectors, etc.

The ICM kits are quite complete; you'll need only wire and solder to build the modules. International Crystal provides detailed instructions for selecting the right components from the ones they supply and for assembling the individual modules. The diagram shows you how to connect the modules together to produce a converter. Before mounting the boards, check your soldering carefully. Look very carefully at the joints where the input and output terminals meet the copper foil. They can easily work loose; it's a good idea to solder each one individually. Use the bolts and spacers supplied to mount the modules on a metal chassis; drill four ⅛-in. holes in a square 1³⁄₁₆-in. on a side for these bolts.

Input-Output. SO-239C coaxial jacks handle the coax cables to the antenna and the transceiver. An spst switch and a snap-type battery clip take care of power connections. A nine-volt transistor radio battery is an adequate power source. However, we prefer to use four AA cells in a holder; the rig works fine on six volts and these cells last longer than the nine volt battery. For long term monitoring you may want to use an external AC power supply; the two

Here's why we stamp this project "goof-proof." Three little sure-fire PC board project kits and a few wires to plug them together pick up short-wave broadcasts and "convert" them to CB channel 9. That's where your CB set takes over. It "picks up" the converted signal; that's why no modification to the CB set is ever required.



PARTS LIST FOR CB TIME CONVERTER

BP1, BP2—5-way binding posts (Radio Shack 274-662 or equiv.)
J1, J2—chassis-mount, SO-239, coaxical jacks
J3—optional crystal socket for "EX" (HC-6/U) type crystals (Amphenol 9748-16-10 or equiv.)
S1—spst toggle switch (ON-OFF)

Misc.—four-cell AA battery holder such as Radio Shack 270-383, cabinet with metal cover about 4-in. x 8-in. x 2-in. such as Radio Shack 270-232, PL-259 coax connectors for input/output signals, wire, solder, etc.

In addition, the following "Experimenter" kits will be required from International Crystal Mfg. Co., Inc., 10 N. Lee, Okla. City, OK 73102: OX oscillator @ $2.95, MXX-1 mixer @ $3.50, SAX-1 RF amplifier @ $3.50, and the proper EX crystal (see text) @ $3.95. Postpaid.

COMMON CRYSTAL FREQUENCIES

Station	CHU	WWV	NWS weather	Marine calling, distress
Freq. (MHz)	7.335	10 5	162.55 162.40	156.8
Crystal (kHz)	19,730.000	17,065.000 22,065.000	45,161.666 45,111.666	43,245.000

binding posts are for this connection.

One last refinement, that is not necessary but certainly is convenient, is an external crystal socket. As shown in the diagram, mount the socket near the OX module and connect two leads (as short as possible) from the OX socket to the terminals of the new socket. This allows you to change frequencies over a narrow range without removing the unit from its case.

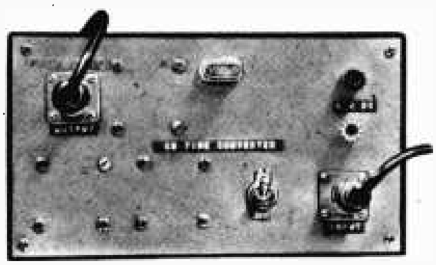
A special word here about using your converter on different frequencies: You should follow the ICM instructions carefully in choosing the right coil and capacitor for the kits. For the OX oscillator, the "yellow dot" coil will probably cover the range you want for time listening. However, with the SAX and MXX, the yellow dot has to be matched with the right capacitor: the 100 pF capacitor tunes the range 5.4 to 8.5 MHz—just right for CHU. For WWV you need the 47 pF capacitor that tunes 8.5 to 13 MHz.

When the modules are securely mounted, make the connections between the units as shown in the diagram. Note that the negative battery terminal is connected to chassis ground with a solder lug. Connections to the boards are made with the little connectors supplied. Take it easy and work carefully with them. First cut your wire to the right length, then strip about ¼-in. of insulation from each end. Hold the "open" end of the connector with long nose pliers; squeeze the connector around the wire end. Secure the wire in place by flowing in some solder. Careful! Don't let solder get into the round end that mates with the pin on the PC board.

Setup. For testing and adjusting your converter, an RF signal generator is useful, but not essential. The tuned circuits in the SAX and MXX can be peaked using an on-the-air signal from CHU or WWV. Adjust the slugs in the coils for maximum volume from the speaker.

Of course, your converter needs an antenna to function properly. When radio propagation conditions are good, almost any piece of wire connected to the center (ungrounded) input will serve. We get good results by connecting both wires from a monitor antenna to the center terminal. This is, in effect, a long vertical antenna. Your CB antenna will probably not work well, since most good CB antennas are effectively grounded for any frequencies except the CB channels (good for lightning protection, but not for receiving 10 MHz).

Shortwave Fix-Tuned. There are many shortwave broadcast stations around the world you might try to snag with a fix-tuned receiver like the one here. The radio can be left "on," always tuned exactly to the broadcaster's frequency. When "skip" on the shortwave bands is just right, and the station is broadcasting, you will be ready to copy. While a separate crystal for every possible frequency is a financial impossibility, and not very practical anyway,



A front panel mounted crystal socket permits moderate shifting of the received frequency without internal retuning. If you use an external 6-volt supply, be sure to remove the dry cell.

you can keep a crystal or two around for your most often used frequencies.

Here is a selected list of shortwave broadcast stations which may interest you. Of course, you should confirm reception in your area with a regular tunable shortwave receiver before sinking your good bucks into a crystal.

Voice of America, Greenville, N.C., 15160 kHz, 2345 GMT, relaying programs of the Organization of American States; Greenville, N.C., 15235 kHz, 1900 GMT.

Canadian Broadcasting Corporation, Sackville, N.B., 11720 kHz, 0200 GMT, Northern Service newscast; Sackville, N.B. 15190 kHz, 0100 GMT, Radio Canada International's foreign service in English.

CFRX, Toronto, Ontario, 6070 kHz, can be heard during the evening hours in North America with programs of CFRB, sounding much like a popular music format U.S. commercial BCB station.

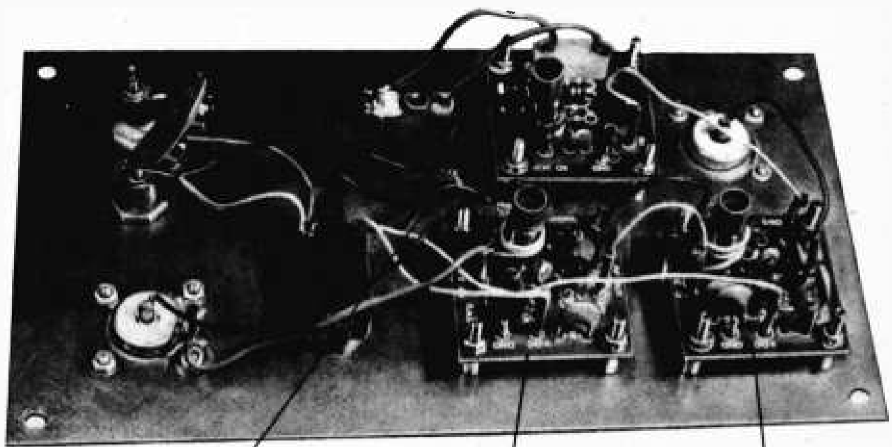
Voice of the Andes, HCJB, Quito, Ecuador, 11745 kHz, English may be heard around 0300 GMT. Or, in the mornings, try 15115 kHz about 1300 GMT.

Radio Peking, Peking, People's Republic of China, 15060 kHz. You can find this station broadcasting in English around 0200 GMT.

Radio Australia, Melbourne, Australia, 11785 kHz. Plenty of English programs from this down under station; listen in about 1400 GMT.

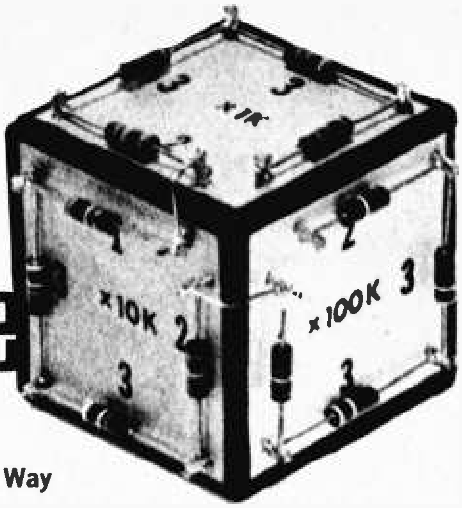
Radio Tahiti, Papeete, Tahiti, 15170 kHz. With music that runs the gamut from U.S. pops to Polynesian melodies, listen for this station from its sign-on at 0300 GMT.

This little converter now makes your CB into a red hot receiver. With the right LO crystals, you can cover your favorite frequency-stops from 3 MHz to 170 MHz. Good signal hunting! ■



R-Cubed lets you Shoot the Works

by R. L. Way



LOOKING for the right resistor during a circuit mockup, or breadboarding, sometimes becomes annoying: dim light makes color band reading impossible; fumbling fingers can't pick up ¼-watt resistors fast enough; and, of course, you are always out of the resistance size you want to use. So get with it with R-Cubed—the experimenter's toy block that makes bench work seem like child's play.

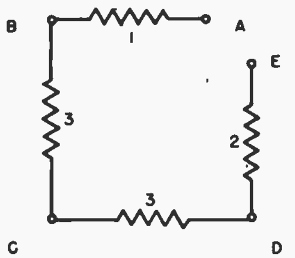
R-Cubed is not so much a device as it is a method for keeping on hand, in an orderly manner, a collection of standard-value resistors that can be used singly with clip-leads, or in series with clip-leads to provide most needed values of resistance. The 24 resistors that can be mounted and series-connected on the faces of a small cube will give resistance values of 1 to 9 ohms and all multiples of 10 of these values through 100,000. Thus, if all 24 resistors are used, resistance values from 1 ohm to 900,000 ohms will be available. The author's unit contains only 12 resistors, since only values from 1000 to 100,000 ohms were desired. In addition, some intermediate values of resistance (for instance, 42 ohms, 780 ohms, 95,000 ohms, etc.) can also be obtained from the R-Cube arrangement, as will be explained later.

One-half-watt, 5% resistors were used to keep down the cost, but the same idea can be applied to 1% resistors, or to 1- or 2-watt resistors. The only other expense, aside from cardboard for the cube, paint, etc., is for a box of vectorboard mini-clips, and a pair of alligator clip-leads. (The Editors took exception to the author's construction technique and went their own way using a child's toy play block and some brass brads—but more on this later.)

Knocking It Together. Four resistors form a *decade* (10, 100, 1000, 10K, 100K, and 1M), and each decade is mounted on one of the six faces of the cube. The resistors are all multiples of 1, 2, and 3 (that is, 10, 100, 1000, etc., 20, 200, 2000, etc., and 30, 300, 3000, etc). Henceforth, all numbers in a decade will be stated as 1-digit numbers, with the understanding that they are multiples of 10, 100, 1000, etc., according to the decade in which they are used. By wiring the four resistors of a decade end-to-end in the order 1, 3, 3, 2, as shown in Fig. 1, any value of 1 to 9 can be obtained by connecting clip-leads between the appropriate mini-clips. This can be better understood by looking at Fig. 1 and its accompanying table.

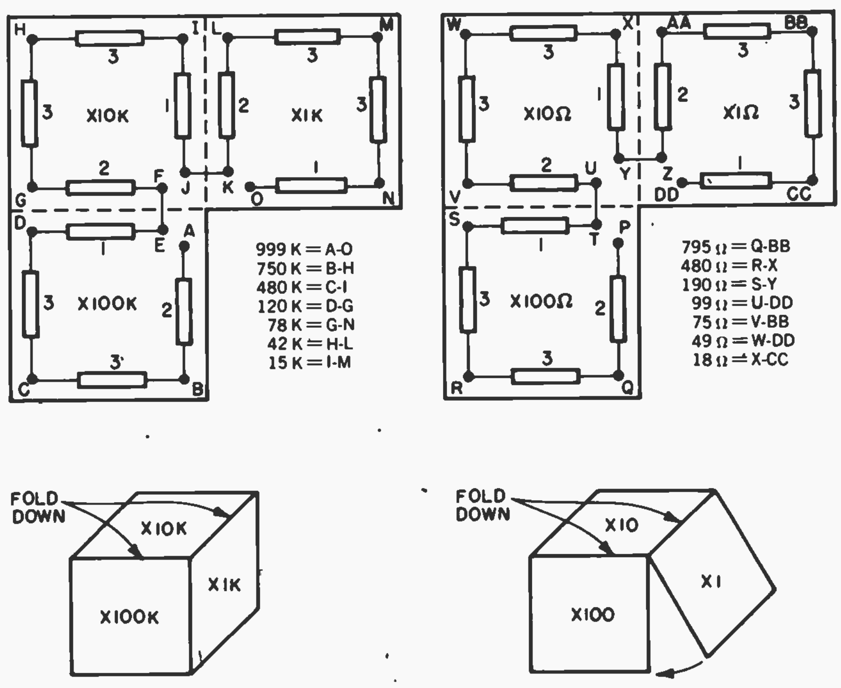
In order to get resistance values between those available on a single decade, the decades are connected to each

(*Continued on page 101*)

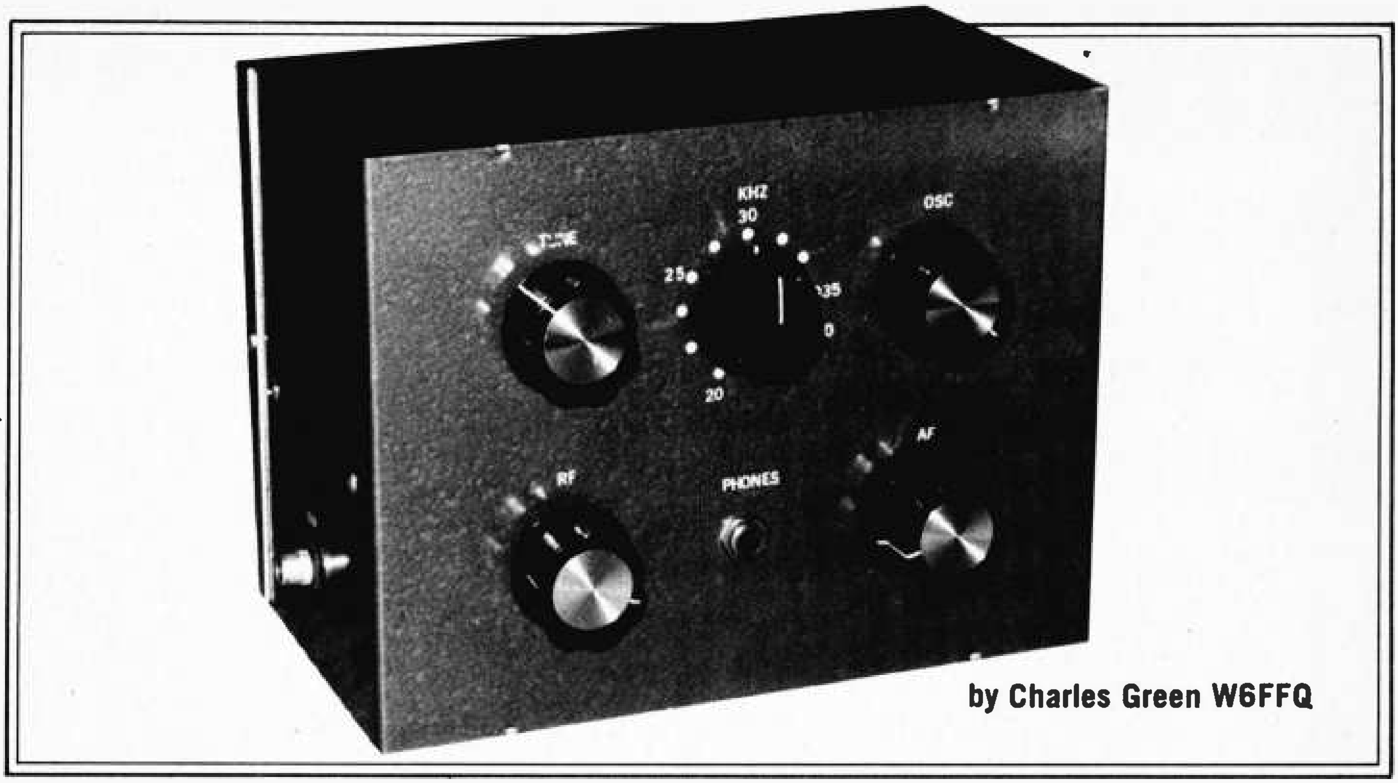


TO OBTAIN	CONNECT LEADS AT
1 ohm	A and B
2 ohms	D and E
3 ohms	B and C
4 ohms	A and C
5 ohms	C and E
6 ohms	B and D
7 ohms	A and D
8 ohms	B and E
9 ohms	A and E
10 ohms	Go to next higher decade

The resistors in each set for each face are valued at 1, 3, 3, 2-ohms each multipled by a factor for that face. The diagram at right is for the X100K face of the cube. Therefore each resistor is valued at 100,000-ohms or a multiple thereof.



Here's how the cube fits together and what resistors go on what face. Note that terminals E-F, J-K, U-T and Y-Z are connected by means of a jumper.



by Charles Green W6FFQ

SUB-BASEMENT RADIO

EXPERIMENTER'S DELUXE FET/IC VLF RECEIVER

JUST AS MANY of the "cliff dwellers" in modern multi-story apartment buildings have little-known basements and sub-basements, the radio spectrum has a "basement" LF (low frequency) band and a mysterious "sub-basement" VLF (very low frequency) band, little known to many electronics hobbyists and experimenters. The LF band goes from 300 kHz down to 30 kHz, and the VLF band from 30 kHz down to 3 kHz.

The lower portion of the LF band, from about 60 kHz to the upper portion of the VLF band (about 18 kHz), is used by the National Bureau of Standards to transmit coded, standard-frequency signals (similar to WWV). Special receivers are used for proper reception of these signals, which automatically adjust electronic laboratory generators to coincide with the standard frequencies. The U.S. Navy has found that the VLF band signals will penetrate into salt water and has established giant high powered transmitting stations that communicate with submerged submarines anywhere in the world.

Other nations maintain transmitting stations in the LF/VLF region for scientific and navigational purposes. These stations are subject to changes in frequency, power, and time of broadcast since there is still considerable experimentation. The stations usually transmit their call signs in CW at periodic intervals for identification.

Receivers for the LF/VLF "basement" transmissions are usually quite complex, but you can sample the activity in this portion of the rf spectrum with our simplified receiver project which covers the most popular portion of the bands from 20 to 50 kHz. This frequency coverage can be changed by using different values of inductances than specified in our plans. Plans are also included for a VLF-style loop antenna to be used with the receiver instead of the usual outdoor dipole antenna used in the higher frequencies. Inasmuch as VLF wavelengths are many miles long, a half wave antenna dipole is impractical at these frequencies.

The receiver uses two ICs and three FETs in a simplified regen detector circuit with a two-stage rf amplifier. Good audio volume is provided for earphone reception, and the receiver is housed in a compact metal utility box. Perf board style construction is used for ease in building the receiver.

The Circuit. Very low frequency signals picked up by the loop antenna are fed through coax cable to the input of IC1, the rf amplifier stage. The amplified signals are fed through C3 to the coil L1 and the second rf amplifier stage, IC2. L1 and the input capacity of IC2 act as a broadly tuned circuit for VLF signals: R2 controls the rf amplification.

Capacitor C6 couples the amplified rf signals to the oscillating detector stage of FET Q1. These signals are tuned by L2 and the S1 switch-selected capacitors of C8 to C18. Variable capacitor C7A/B acts as a fine tuning control for the VLF signals, and R5 controls the oscillation point and, therefore, the sensitivity of the detector stage.

The detected audio signals are fed through the low pass filter R7/C20 and coupling capacitor C21, to the audio gain control R8 and audio amplifier stage Q2. The amplified audio signals are coupled via the L3/C23 peak filter to the second audio amplifier stage of FET Q3. The peak filter is tuned to approximately 800 Hz to provide better receiver selectivity of the

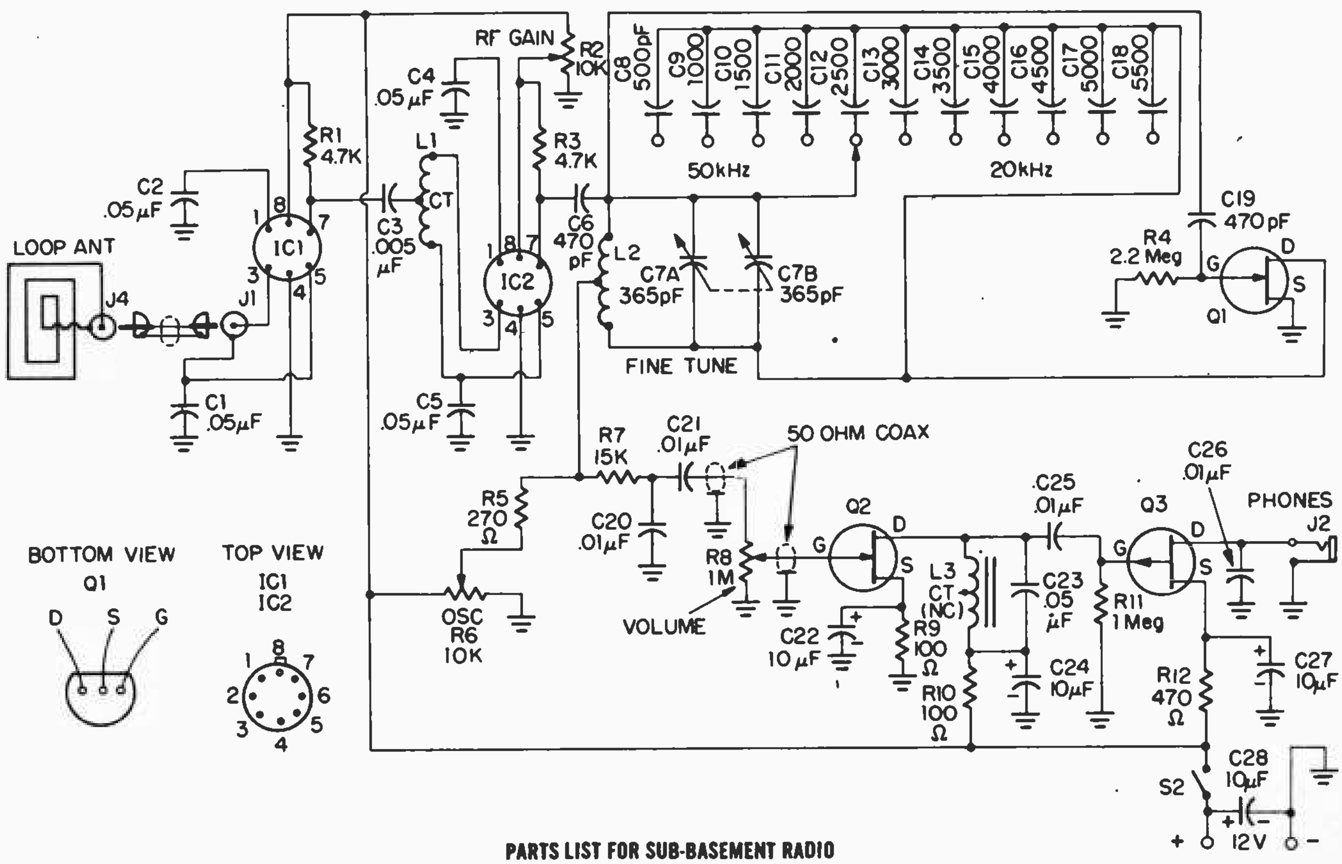
SUB-BASEMENT RADIO

VLF signals. The amplified signals are fed from the drain circuit of Q3 to J2 and can drive high impedance earphones (2000-ohm type).

Field effect transistors Q2 and Q3 form the audio amplifier stages. Q3 is a P-channel FET and therefore requires a relatively negative potential on its "drain" terminal. This is accomplished by grounding the drain through the earphone and returning the "source" to the positive power supply terminal.

Construction. Coils L1 and L2 are made from miniature transistor audio transformers by removing the laminated iron core. We used 10,000-ohm to 2,000-ohm center-tapped transformers for the coils in our receiver. The connections are made to the 2,000-ohm center-tapped winding only; the leads to the 10,000-ohm winding should be cut off close to the coil form. Coil L3 is a 1,000-ohm CT to 8-ohm miniature output transformer and is used *with* its iron core intact. The 1,000-ohm winding is used (no connection is made to the center tap), and the 8-ohm and center tap leads should be cut off close to the coil form.

The receiver operation is at low rf frequencies, but the wiring of the receiver should still be carefully done. For best results, follow our component layout as shown in the photos. Your best way to start construction is to cut a 4¼ x 7⅞-in. section of perf board and install it approximately halfway up the LMB-146 aluminum box. We used two 4¼-in. lengths of sheet aluminum



PARTS LIST FOR SUB-BASEMENT RADIO

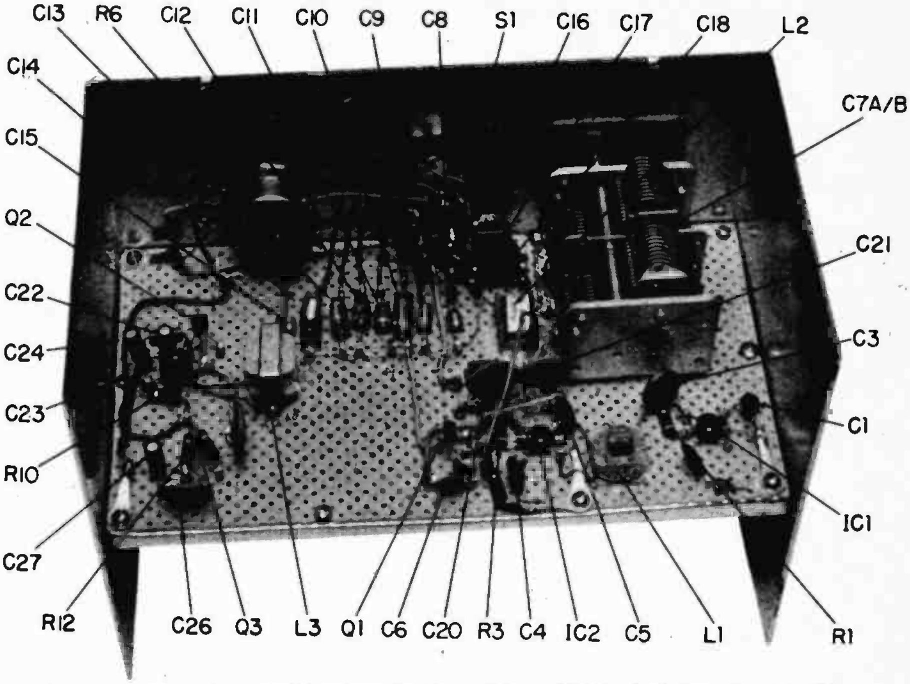
C1, C2, C4, C5, C23—0.05-uF capacitor, 12-VDC or better
C3—0.05-uF capacitor, 12-VDC or better
C6, C19—470-pF capacitor
C7A/B—dual-gang 365-pF variable capacitor (TRW 273 or equiv.)
Note—A dual-gang 365-pF variable capacitor may be difficult to obtain. You can go the same route as pioneer radio builders by using two single-gang 365-pF variable capacitors and operate them in tandem (turn each knob the same amount).
All capacitors 15-VDC or better
C8—500-pF (see text for all capacitors, C8 to C18)
C9—1000-pF
C10—1500-pF
C11—2000-pF
C12—2500-pF
C13—3000-pF
C14—3500-pF
C15—4000-pF
C16—4500-pF
C17—5000-pF
C18—5500-pF
C20, C21, C25, C26—0.01-uF capacitor
C22, C24, C27, C28—10-uF electrolytic capacitor, 16-VDC
IC1, IC2—703-type integrated circuit
J1, J3—insulated phono jack, RCA type (see text)
J2—two-conductor phone jack
L1, L2—inductors made from small 10k to 2k audio driver transformers
L3—inductor made from small 1k to 8-ohm audio output transformer (see text)
Q1—N-channel FET, HEP-802 (Motorola)
Q2—N-channel FET (see text)
Q3—P-channel FET (see text)
R1, R3—4700-ohm, ½-watt resistor
R2, R6—10,000-ohm potentiometer, linear taper
R4—2.2 meg, ½-watt resistor
R5—270-ohm, ½-watt resistor
R7—15,000-ohm, ½-watt resistor
R8—1 meg potentiometer, audio taper
R9, R10—100-ohm, ½-watt resistor
R11—1 meg, ½-watt resistor
R12—4700-ohm, ½-watt resistor
S1—single pole, 11 position rotary switch (Calectro E2-161 or equiv.)

Misc.—aluminum cabinet 8-in. x 6-in. x 4½-in. (Author used LMB 146), perf board, push-in clips, 50-ohm coaxial cable, knobs, hook-up wire, No. 28 enameled wire, plastic tape, solder, etc.

bent into brackets with sides approximately ¼ x ½-in. (½-in. side mounted to the box wall, and the ¼-in. side mounted to the perf board). Additional lengths of ¼-in. wide sheet metal stiffeners were added to the side of the perf board to increase the rigidity of the board. This may not be necessary in your unit.

More Mechanics. Locate C7A/B on the front panel as shown in the photos, and then cut a ½-in. or larger hole for the shaft. This will allow the frame of C7A/B to be mounted to the perf board and allow the shaft to protrude through the front panel without touching the metal panel. Note that the shaft *must be* insulated from the panel, or it will short the B+ at the detector circuit. If necessary, you can use an insulated coupling for the shaft. Make sure that you use a plastic tuning knob to minimize the possibility of short circuits.

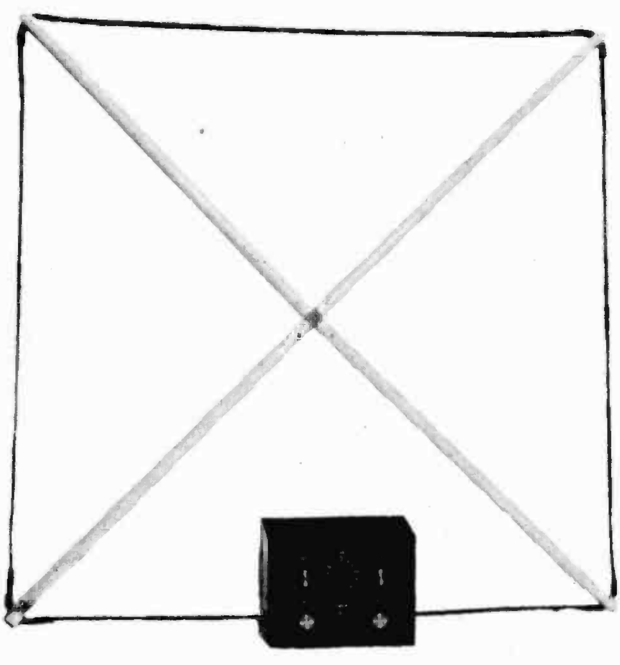
Locate and install the remainder of the front and side panel controls and components as shown in the photos. Make sure that you install serrated washers between the control bushings and the inside of the panels to prevent accidental disturbance of the position of the controls. Also, use insulating washers for J1 to keep the jack body from electrical contact with the box panel and electrical ground.

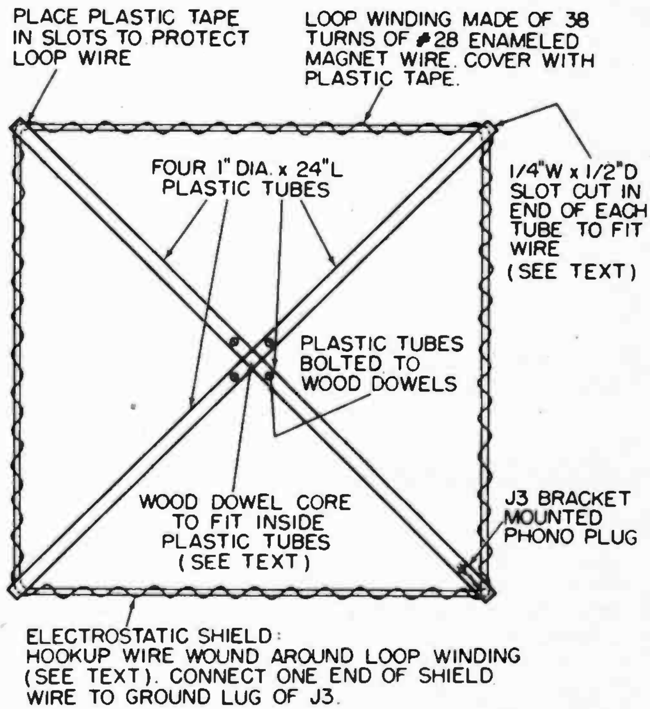


These are the major parts locations for the perf board. Note dual-gang cap C7A/B.

Most of the components on the perf board are connected to push-in clips. Keep the component leads as short as possible and group them around their particular IC or FET as shown in the photos. Wire the components as indicated in the schematic drawing and position the leads as shown in the board photo.

Coil forms L1 and L2 can be either cemented to the top of the perf board, or (as in our unit) held with an application of hot plastic glue from an electric glue gun. Use short lengths of coax or shielded wire to connect R8 to the perf board components as shown in the



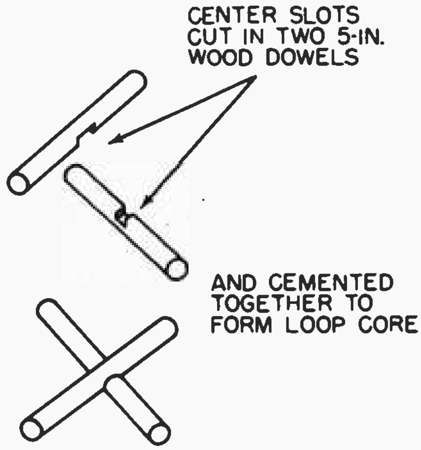


Reinforced PVC tubes available from building supply outlets are lighter and easier to work with than dowel sticks when building an open air antenna support frame. The RCA-type phono connector makes a convenient way to use standard audio cable.

SUB-BASEMENT RADIO

photo. Connect ground lugs at the board corners and on the C7A/B mounting screws for the necessary electrical circuit connections.

Capacitors C8 to C18 should have as accurate a capacity value as possible (select them on a capacitor bridge if possible), and they can be either ceramic or polystyrene types. Mount them with short leads around S1 and connect them with straight direct leads to the S1 lugs. If necessary, you can parallel capacitors to make up the required capacity values. Connect the remainder of the front and side panel controls and jacks to the board circuits, and position the leads as shown in the photos.



Dowel sticks for this assembly are available from lumber yards, hardware store and hobby shops. Notch with a wood chisel or a keyhole saw or whittle with a pocket knife.

The Loop Antenna. As shown in the drawing, the loop antenna is composed of four 1-in. diameter x 24-in. long plastic tubes. We used polyvinyl chloride (PVC) tubes that can be obtained from a building supply store. Or any type of plastic tube can be used as well. The plastic tubes are fitted over a wood-dowel center core as shown in the drawing, and the loop antenna wires are wound over the slots in the tube ends.

Begin construction of the loop antenna by cutting center slots in two 5-in. long wood dowels (of a diameter to fit snugly into the plastic tubes), and cement them together as shown in the drawing. Wood screws can be used in place of cement, or hot glue from an electric glue gun can be used as we did in our model.

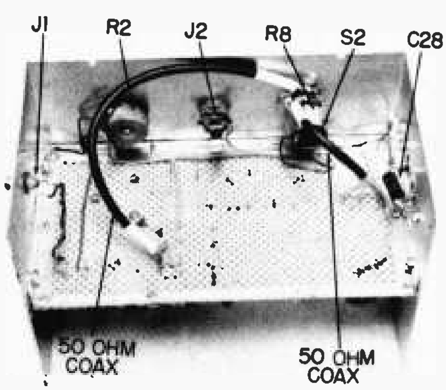
Cut the plastic tubes to size and then cut a ¼-in. x ½-in. deep slot on one end of each tube. Then mount the tubes to the wood dowel core with the slotted ends outward and parallel to allow the loop antenna wires to be wound around the ends as shown in the drawing.

The front panel control knob "osc" sets the regenerative feedback point of the detector FET Q1 (it sets the audible "plop" point!). That "tune" knob is actually a fine-tune of the bandswitch-like "kHz" (course) control.

Place plastic tape in the tube slots to prevent the wire from being abraded, and wind the loop with 38 turns of #28 enameled magnet wire, and cover the wires with a layer of plastic tape. Connect the loop leads to a phono jack (J4) mounted on the end of one of the plastic tubes.

To minimize noise pickup, wind an electrostatic shield composed of a spiral winding of hookup wire around the antenna loop. Leave about 1-in. spacing between the electrostatic shield wire turns, and connect one end of the wire to the "low" side (shell) of J4. The other end of the electrostatic shield wire should be taped so that it will not cause any accidental short circuits.

A length of good quality phono or coax can be used to connect the loop antenna to the receiver. Make sure that the "low" sides of P4 and J1 are connected together (the outside shells of the jacks).



Experimenters should use a short length of 50-ohm coaxial cable for vol. control R8 connections (mini-type RG-174U or RG-58 U).

Range and Panel Markings. We used rub-on decals for the panel markings for our receiver model, but neatly drawn pen and ink markings on white tape can be used as well.

The receiver does not require any calibration for exploratory operation on the VLF band, and you can designate the approximate frequency of the S1 kHz switch as follows: 20 kHz (C18=5500 pF), 25 kHz (C15=4000 pF), 30 kHz (C13=3000 pF), 35 kHz (C10=1500 pF), 40 kHz (C9=1000 pF), 45 kHz (C8=500 pF).

For more accurate calibration with the transformers you used for L1 and L2, connect an audio oscillator to J1 through an isolating audio transformer.

Testing and Operation. The loop antenna can be suspended with a length of cord from one of the plastic tubes for easy rotation and operation indoors. Or the loop can be placed on a wooden chair for temporary operation. Note, however, that the loop should be away from AC appliances for best performance.

Set all controls to the extreme counter-clockwise position, and connect the receiver to a 12 volt DC power supply or battery. Connect the loop antenna to J1 with either coax or a length of good quality phono cable, and plug in a set of high impedance earphones at J2.

Adjust the *audio gain* (R8), *rf gain* (R2) and *fine tune* (C7A/B) controls to mid-range. Adjust the *osc* control (R5) clockwise until the detector circuit (Q1) is oscillating. There will be a "click" or "plopping" sound in your earphones when the detector stage first falls into an oscillating condition. Keep adjusting the *osc* control (R5) near this point for best sensitivity when tuning for signals. Adjust R8 and R2 for best reception of signals.

Adjust the *fine tuning* control (C7A/B) for each setting of S1 as you listen in on the VLF band from 20 kHz to 50 kHz. Reposition the loop antenna as necessary for best reception of signals. Practice is required to obtain the proper "feel" for operating the receiver controls. You can also try different loop antenna assemblies with different turns of wire for best results in VLF reception over different portions of the band. You can experiment with the tuning range by changing the values of L1 and L2.

Remember, this is an experimenter's project exploring the little-known, little-tuned very low frequencies. It's a good first-step project into VLF; why not "kick in" right now! ■

This Plain Jane occasional table conceals...

SOUND FORCE

a 3-way speaker system with downward facing woofer!

by Herman F. Johnson

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

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

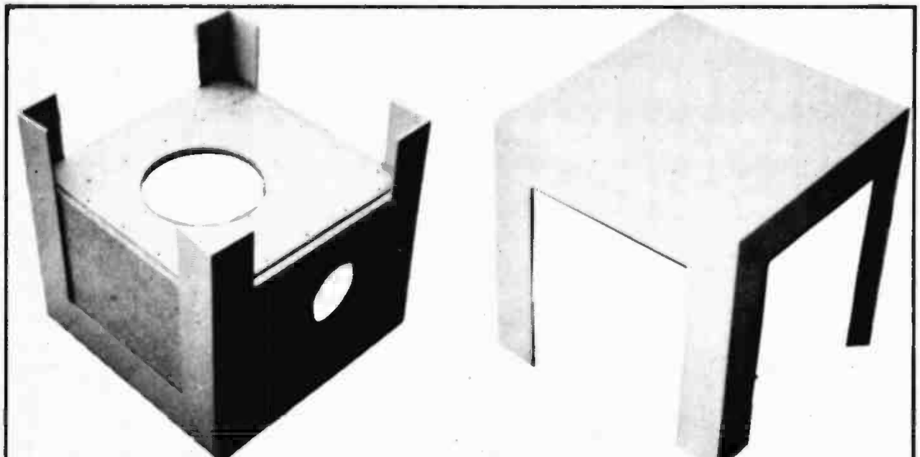
Construction. Before you purchase the speakers, locate a 16-in. cube-shaped occassional table. They are made of high gloss plastic in black, yellow, red and gray colors. Take a good look at the construction of the table before you decide upon the color. The table legs must be right angle shaped, not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

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

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

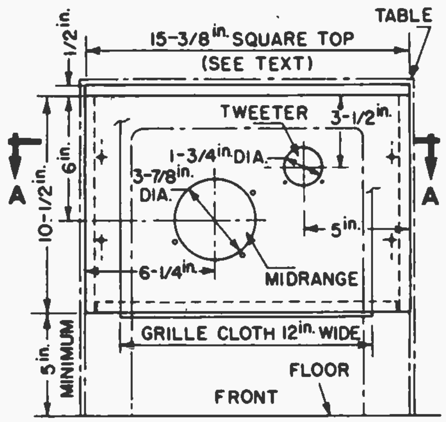
Construction Sequence. You will need a half sheet (48 x 48-in.) of plain particle board, ½-inch thick. Half a sheet is more than enough to build one enclosure, but it is not enough for a stereo pair. When the panels have been cut to size as indicated in the drawings, lay out the center locations for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

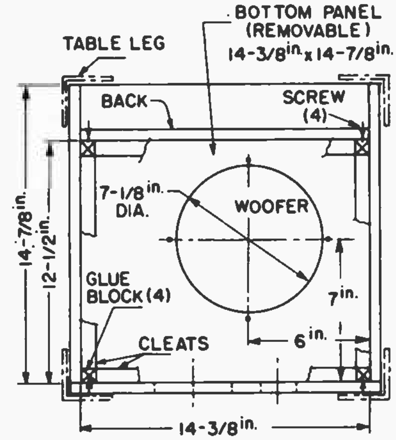
Ten feet of ¾-in. square pine is required for cleats and glue blocks. See



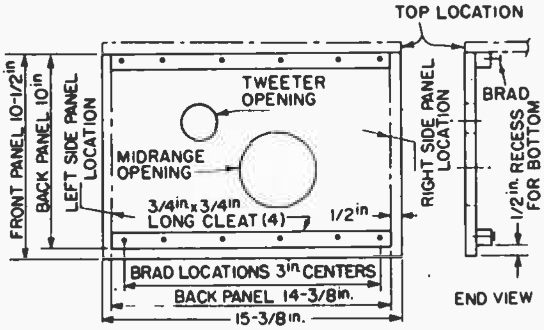
Check the Bill of Materials appearing on the last page of this article. Of course, you must have one set of materials for each speaker you wish to build. You should always use "zip" cord for speaker connections on moderate and high power installations; never that thin stuff sometimes sold on spools as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

SOUND FORCE



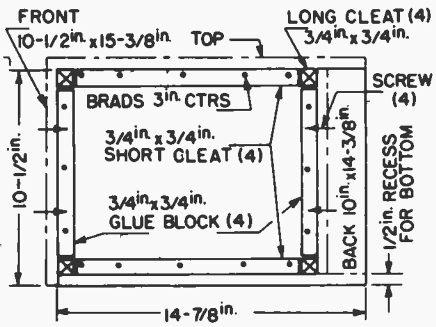


VIEW "A-A"
(INSIDE)

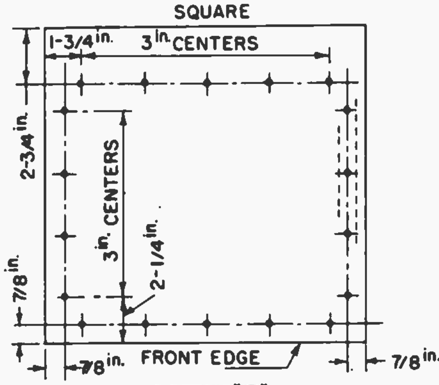


DETAIL A
FRONT PANEL, INSIDE FACE
(BACK PANEL SIMILAR, WITHOUT SPEAKER OPENINGS)

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

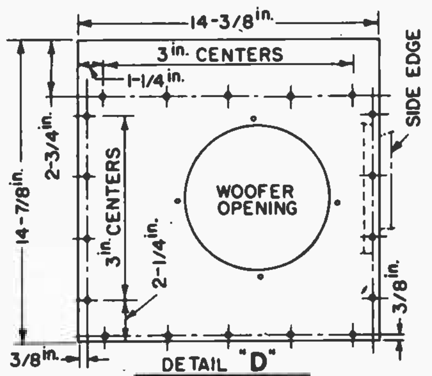


DETAIL "B"
LEFT SIDE PANEL, INSIDE FACE
(RIGHT SIDE PANEL SIMILAR)



DETAIL "C"
(TOP PANEL)

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



DETAIL "D"
(BOTTOM PANEL)

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

Next, lay out the screw hole centerlines on the top and bottom panels as shown in Details "C" and "D". Center punch each screw location and drill 1/16-in. holes as indicated. Then, assemble the front, sides, and back panel in the position shown in view "A-A" and align the top panel. You are now ready to mark screw locations into the top side of the cleats with the 1/16-in. drill. At this point you should examine the screw locations to see if any screw is likely to hit a brad when it is driven. If a screw location appears to be too close to a brad, it is best to drill another hole ¼ or ½-in. away from the brad. When you are satisfied that all screws will clear, reassemble the same panels, down side up, and repeat this process for the bottom panel. When you are satisfied that all screw holes are in the clear, re-drill all of the holes 9/64-in. diameter and countersink for No. 6 screws. It is to be noted that four (4) screw holes are required in the front and back panels for screwing into the glue blocks. All of the panel edges should be given a coating of resin sealer to prevent flake off.

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

Speaker Component Installation. All of the speakers are mounted to the inside face of the panels. However, the diameters indicated in the drawings will allow the two cone drivers to be "backed in" to their respective openings on the inside faces of the panels, so each driver will be centered in the opening. In this position, center punch all four (4) mounting holes from the frame of each unit. Remove the speakers and drive ½-in. No. 8 sheet metal screws into the panels about ¼-inch deep. Then, remove the screws and scrape off the displaced wood around each screw hole. This procedure will prevent damage to the cone of a speaker should a screwdriver slip when driving a screw. The woofer and the tweeter should be mounted with screws. The hole locations you have marked for the mid range unit should be drilled 11/64-in. or 3/16-in. in diameter for 8-32 machine screws.

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

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

Cut the speaker hookup wire (zip cord is fine) in about 24-in. lengths. Solder one of these to the woofer terminal lugs, one to the midrange lugs (through a snug fit hole in the side of the plastic cover), and the third to the pull-type binding posts located on the tweeter. Red dot terminals on the speakers should be connected to their respective plus (+) terminals on the network (2, 8, and 10). Unmarked terminal lugs should be connected to the negative (common) terminals on the network (1 and 6). Since two wires must be connected to terminal 6 in a 3-way system, it is a good idea to use spade connectors. The input terminals are located adjacent to terminals No. 1 and 2. The input terminal adjacent to terminal No. 2 is the plus (+) terminal.

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

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

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

Before inserting the enclosure into the table, examine the inside skirt edges of the table below the top. If these edges are a sharp right angle, round them over with a file to avoid abrasion of the grille.

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

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

BILL OF MATERIAL FOR SOUND FORCE

Quantity	Name	Size	Material
1	top panel	15 3/5-in. sq.	½-in. particle board
1	bottom panel	14⅜-in. x 14⅞-in.	
2	side panel	14⅜-in. x 14⅞-in.	½-in. particle board
1	front panel	10½-in. x 15⅜-in.	½-in. particle board
1	back panel	10-in. x 14⅜-in.	½-in. particle board
4	long cleats	¾-in. sq. x 14⅜-in.	pine
4	short cleats	¾-in. sq. x 11-in.	pine
4	glue blocks	¾-in. sq. x 8-in.	pine
44	flat head wood screws	1-in. No. 6	—
4	machine screws	1¼-in.	—
7	sheet metal screws	½-No. 8	—
60	wire brads	1-in.	—
1	occasional table	16-in. x 16-in. x 16-in.	plastic
1	woofer	8-in. (Radio Shack 40-1341)	—
1	mid-range	5-in. (Radio Shack 40-1292)	—
1	tweeter	1¾-in. (Radio Shack 14-1274)	—
1	network	3-way (Radio Shack 40-1339)	—

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

RADIO HISTORY

by Art Trauffer

☐ Here are some ideas suggesting how to make novel pen sets that bring back fond memories to old-timers in wireless and radio. The pen sets also fascinate newcomers in radio and electronics, and they make nice gifts.

As shown in the illustrations, an early wireless or radio item such as a vacuum tube, crystal detector stand, or spark gap is mounted on a block of marble, onyx, or wood, and then a funnel and pen is added to complete the desk pen set.

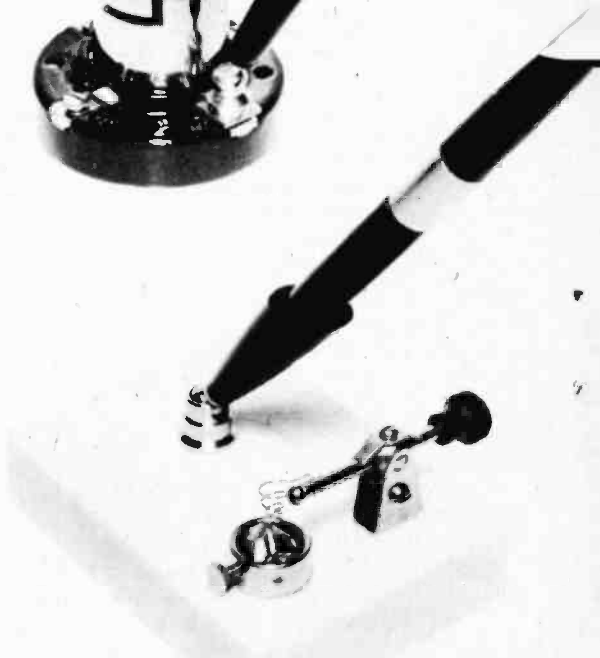
Old-timers in radio might want to use the crystal detector they made or bought for their first crystal set, or the first tube they used when they graduated to tube sets, or the spark gap they made or bought to use with their Ford spark coil transmitter. Newcomers in radio and electronics can purchase the above early items from antique radio collectors, or they can make their own crystal detector stands and spark gaps using the illustrations as guides.

Marble and onyx blocks can sometimes be found at sales, or they can be purchased from large electric lamp supplies firms, or from firms that make sports trophies. Funnels and pens can be purchased from the larger hobbies and crafts dealers. The table gives some purchasing tips.

To mount items on marble and onyx blocks you can either drill holes using high-speed drills (at slow speeds), or masonry drills, or you can simply cement the items on the blocks using epoxy glue or the new industrial "wonder glues." ■

Here is a Western Electric 216-A triode tube mounted on a block of onyx purchased at a sale for a few cents. The four pins on the bottom of the tube base were soldered to a small brass disc and then the brass disc was cemented to the onyx block with epoxy glue. The ball joint of the pen funnel was also glued to the onyx block.

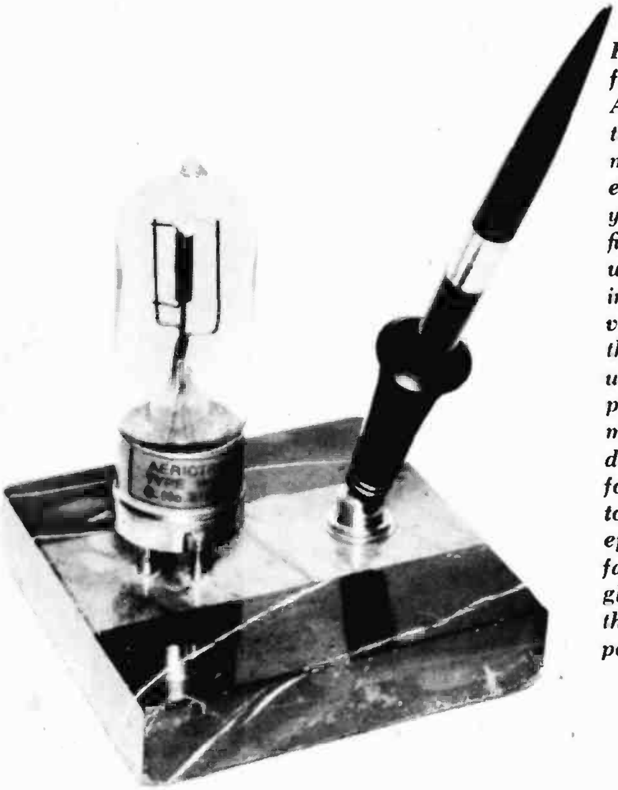
A novel pen set idea is a Western Electric 203-D triode (similar to a VT-1) mounted in an RCA UR-542 porcelain bayonet-type socket. One of the binding post screws was removed from the socket and a 6-32 x ¼ in. flat-head machine screw was passed through the hole to hold the ball joint of the pen funnel. If desired, you can cement the pen funnel to the socket using epoxy, or "miracle glue." Four small felt pads were added to the bottom of the socket.



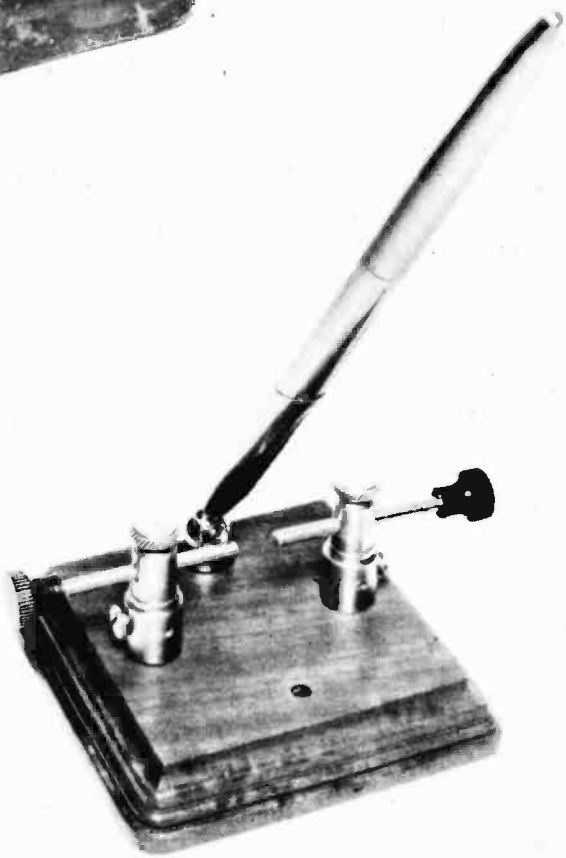
The author used a marble block removed from a discarded basketball trophy purchased for 75¢ at a Salvation Army store. The hole in the block was used for mounting a funnel and pen. The crystal detector parts were glued to the block with epoxy glue.

ON YOUR DESK

Bring back the days of "wireless" glory with these fascinating and useful souvenirs!



Here we have the famous Westinghouse Aeriotron (WD-11) triode tube which made a big hit in the early 1920s because you could heat the filament (1.1 volts) with a 1½-volt drycell instead of using a 6-volt storage battery. In this case, the author used a desk pen set purchased at a rummage sale for 50¢, and drilled four small holes for the tube base pins to fit in, and then used epoxy glue to hold it fast. Green felt was glued to the bottom of the marble to protect polished desk surfaces.



Here is a home-brew stationary spark gap, such as used in the early days of radio—known then as "wireless." Many of you old-timers will recall using a Ford Model-T spark coil to provide the high voltage for the spark! Assembly is easy. Simply pass a machine screw through one of the mounting holes in the base of the spark gap to hold the ball joint of the pen funnel. Glue felt to the bottom of the base to protect polished desk surfaces.

POSSIBLE SOURCES FOR DESK PEN SET MATERIALS

Marble and Onyx Blocks

Salvation Army, Goodwill Stores, auctions, rummage sales

Gilbert & Miller, Inc., 239 New Main St., Yonkers, NY 10701. (This company supplies marble and onyx blocks, as well as pens and pen funnels. Write for catalog.)

Pens and Pen Funnels

Gilbert & Miller, Inc. (see address above) Large hobbies and crafts supplies stores

Green Felt

Notions and yard goods departments of department stores

Early Vacuum Tubes

Antique radio collectors (The following two antique radio newsletters also might be helpful: Antique Radio Topics, published by Antique Radio Press, P.O. Box 42, Rossville, IN 46065—50¢; and The Horn Speaker, published by Cranshaw Publications, P.O. Box 12, Kleberg, TX 75145—also 50¢.)

Watch ads in Collectors News, Antique Trader, etc. for antique radio collectors and dealers wanting to sell early radio vacuum tubes.

Crystal Detector Stands

Modern Radio Labs., 1477-G, Garden Grove, CA 92642

Bill Baker, Route 3, Box 1134, Troutdale, OR 97060 has some Kilbourne & Clark crystal detector stands (circa early 1920s) to sell. Write him for prices.

Crystals

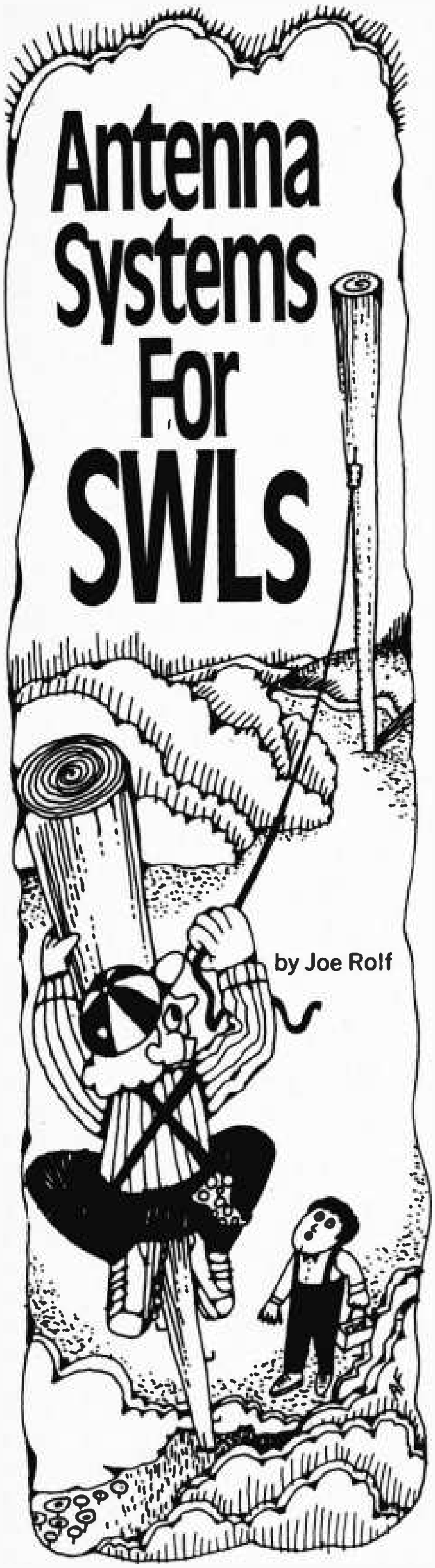
Modern Radio Labs. (see address above) sells various types of crystals. Write for details and prices

Art Trauffer, 120 Fourth Street, Council Bluffs, IA 51501 sells genuine MPM (Million Point Mineral) unmounted galena crystals in original factory boxes (circa early 1920s) at 50¢ each, plus postage.

Spark Gaps

Buy from antique radio collectors and dealers.

Antenna Systems For SWLs



by Joe Rolf

These antenna ideas will help you pull in those elusive shortwave stations.

IF YOU'RE AN armchair shortwave (SW) traveler, you've probably already read through the shortwave stations listed in White's Radio Log, located in e/e's sister publication COMMUNICATIONS WORLD. Maybe, with mouth-watering anticipation, you've tried to hear Rabaul, Upper Volta, Yemen, Hanoi, or Vientiane. If you haven't been successful, be patient; because that's what it takes—patience—*plus* a good SW antenna. We can't supply the patience, but here are some good antenna ideas which are sure to help.

No matter what shortwave receiver you're using, a good antenna is a must to bring in those distant stations. If it weren't, the manufacturer wouldn't have supplied antenna terminals! The problem is what kind of antenna—a hunk of wire? or maybe something more scientific? We'll help you make the decision by telling you a little about SW antennas and how they work.

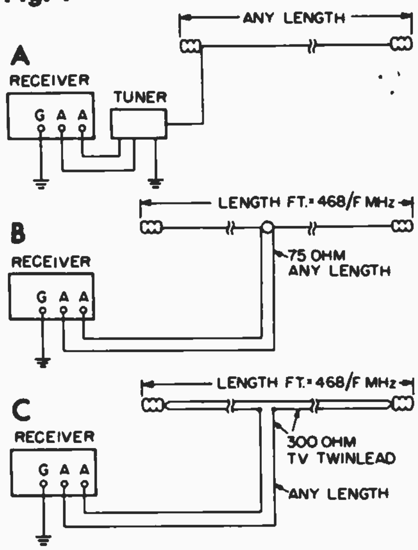
Shortwave antennas can be short and simple or they can be complicated and cover several acres. For shortwave listening most of us are limited to the short and simple ones—those that fit in a backyard and don't cost too much. But even a simple antenna, properly designed and installed, can work wonders.

Fig. 1 shows several commonly used SW antennas with lengths shown for the SW broadcast bands. The antenna in Fig. 1A is known as an unbalanced end-fed longwire. It can be hung horizontally or vertically, or a combination of both. When hung horizontally it has some degree of directionality, while it tends to be omnidirectional when vertical. This antenna will work well on all frequencies if it is made long enough, or it can be cut to operate at only certain frequencies. It works best with an antenna tuner that can be located at the receiver, since the lead-in is part of the antenna's total length. The longwire has a high terminal impedance and always operates best with a tuner that matches the antenna to the receiver. With an antenna tuner, it is an ideal antenna to run around the eaves of the house, or across the attic.

Another Type. Figs. 1B and 1C show the popular centerfed balanced dipole. This antenna can also be hung vertically or horizontally and uses two balanced leads to the receiver that can be any length. This antenna is always cut to a resonant length, though it will also work well at three times the resonant frequency. For instance, an antenna that works in the 90 meter SW band (3.2-3.4 MHz) will also work for the 31 meter band (9.5-9.7 MHz). If space is limited, its ends can be bent down (or even back) as much as 25 percent before reduction in performance becomes serious. Fig. 1B shows a single-wire dipole fed with 75-ohm feedline which can be plastic appliance cord. Fig. 1C shows the folded dipole version built from 300-ohm twinlead. The folded dipole, incidentally, will work well at half the resonant frequency.

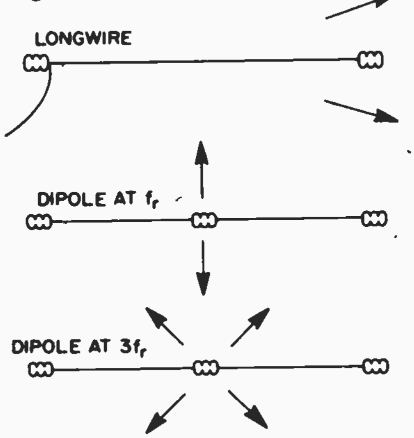
As previously mentioned, a vertical antenna tends to be omnidirectional, while a horizontal antenna tends to have directional characteristics. For general around-the-globe listening the vertical antenna is probably best, though low frequency resonant antennas are difficult to orient in this position because of their length.

Fig. 1



Directionals. If you are interested in DX from a particular part of the globe, however, the directional characteristics of a horizontal antenna can work for you. Fig. 2 shows the direction of maximum pickup for the horizontal longwire and dipole. By looking at a globe and determining the shortest path to the

Fig. 2



area you want to hear, you can position your antenna and use its directional characteristics to advantage.

Fig. 3 shows how directionality can be further increased by bending the ends of the dipole inward. This type of antenna can be easily built by using a center support, such as a TV mast, and bringing the ends in and down toward the ground. For best results, the ends of the antenna must be 10 feet or more above the earth.

A more elaborate antenna that will "look" in any one of four directions can be made by mounting two dipoles in this manner at right angles and connecting the lead-in to different elements to achieve the desired direction. This deluxe array has a disadvantage in that you must have easy access to the top, or center part, in order to change lead-in connections.

Fig. 3

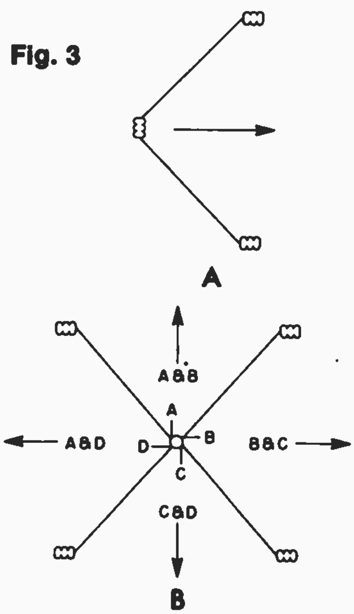
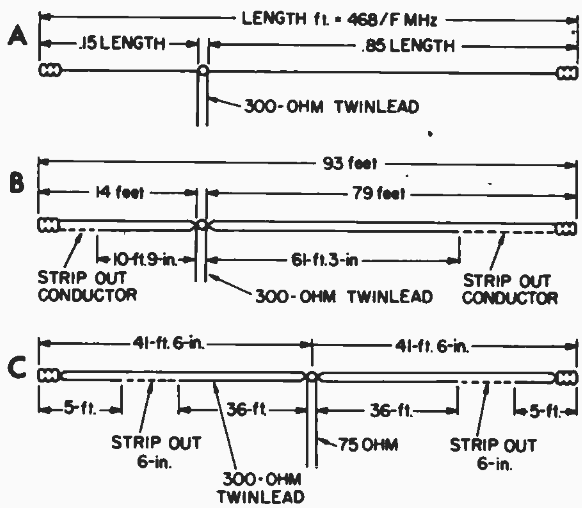


Fig. 4



Three porcelain antenna insulators are used for antenna A. One separates each section of the antenna at the point of feedline connection. The other two insulate the antenna ends from the supporting structure. The antenna at B uses 300-ohm twinlead for the transmission line and the antenna elements. Only the ends at the feedline connections are wound together and soldered. Outside ends are separated, with one partially removed as shown. At C the use of 75-ohm line is called for.

Fortunately, choice DX can be logged on any of the eleven international broadcast bands; but it is difficult (if not impossible) for the serious SW listener to come up with a good antenna for each of eleven bands. Few SWLs have the real estate or inclination to put up a single tuned antenna for each band, so a couple of multiband antennas running in different directions is often the answer. Fig. 4 shows simple multi-band antennas that can be used; and, through compromises, they will give all around performance.

Still Around. The basic antenna shown in Fig. 4A was popular in the 1930s, and is known as the "windom" antenna. It can be fed with 300-ohm TV twinlead, and works well on even harmonics of the fundamental frequency.

Figure 4B shows how, by using 300-ohm twinlead, two antennas can be connected to the same lead-in to give satisfactory performance on the 60, 49, 41, 31, 25, 19, 16, 13, and 11 meter bands. This permits coverage of 9 of the 11 international broadcast bands with a single antenna. By tying the lead-ins together at the receiver and using an antenna tuner, this antenna becomes a longwire, making it probably the most versatile SW antenna available.

Another multiband antenna shown in Fig. 4C consists of two centerfed dipoles made from 300-ohm twinlead connected to the same feedline. This antenna has the advantage of being short (nice for small city lots, or apartment dwellers) and performs well on the 60, 49, 41, 25, 19, 16, 13, and 11 meter bands. Again, it can be connected as a longwire at the receiver and used with an antenna tuner.

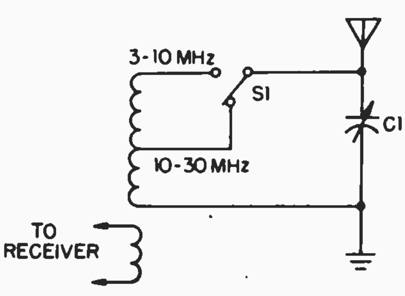
The circuit of a simple SWL antenna

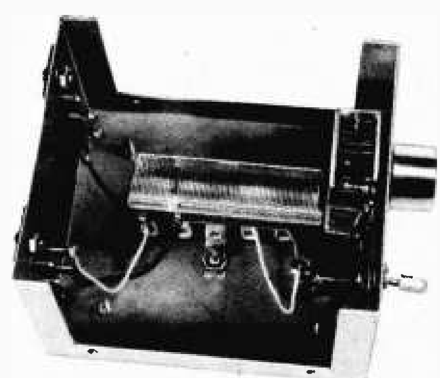
(Continued on page 100)

BUILD A SIMPLE SWL ANTENNA TUNER

Here's a simple antenna tuner any SWL can whip together in an evening and use for a lifetime. Neatness counts when monkeying with low level RF, so mimic the author's model for best results. Keep solder connections clean.

Fig. 5





C1—365-pF miniature variable capacitor

L1—31 turns/in., ⅝-in. diam. coil stock, B&W 3008, Air Dux 532T, etc.
Note: Measure coil and cut ½-in. from one end. Remove one turn in either direction. Measure ½-in. and solder tap to one turn (bend adjacent turns inward for access). Coil ends mount to terminal strip for stability.

S1—Spdt toggle switch

Misc.—2-lug terminal strips for antenna, ground and receiver connections, knobs, wire, solder, 3¼ x 2¼ x 4-in. cabinet, etc.

Both young and old radio buffs usually start out with a crystal set . . .

OATMEAL BOX CRYSTAL

Fig. 1
Sliding contacts made from brass and steel.

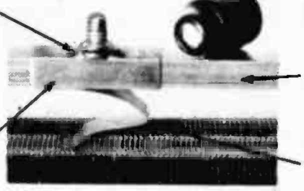
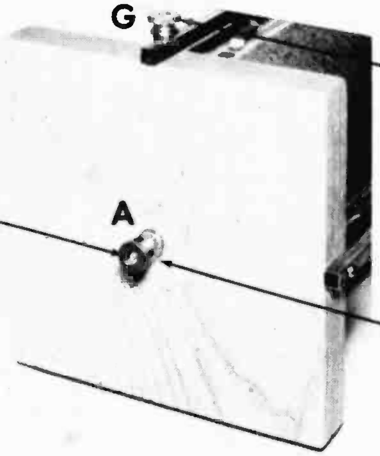


Fig. 2 **Antenna and ground end of the Quaker Oats radio.**



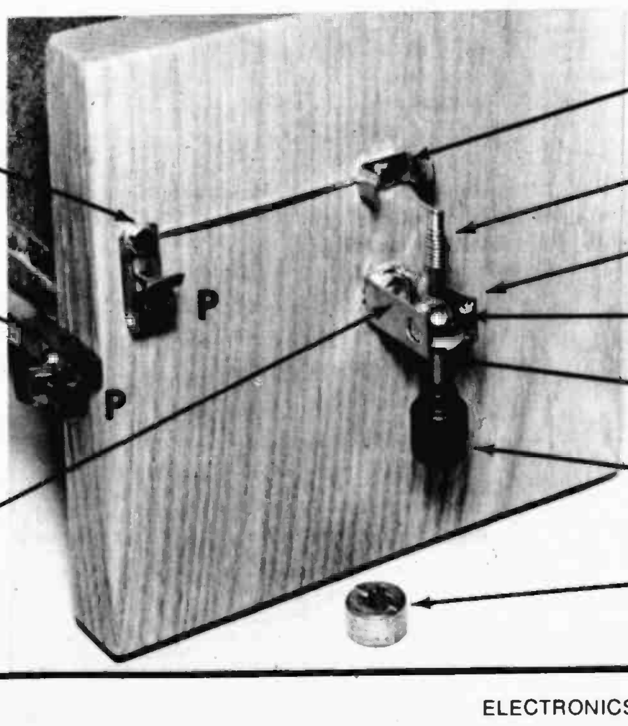
ASK JUST about any radio old-timer, including this writer, and he will probably tell you that his first radio was a home-brew slide tuning coil wound on an oatmeal box, a cat whisker and galena crystal detector, and a pair of earphones. This picture story shows how to make such a radio, and it looks much like the writer's first radio built not long after World War I.

First, make the coil. Remove the two end covers from an 18-ounce, round Quaker Oats box, and cut the tube to a length of about 6½-in. Give the tube a coat of shellac inside and out to moisture-proof it.

The writer used #21 single-cotton-covered enamelled copper magnet wire, and after the coil was wound the cotton was colored green by painting it with India ink to make it look like the old-time green silk-covered wire which is no longer being made. If you prefer, use #20 or #21 enamelled or nylon-coated copper magnet wire, and one pound should easily do it.

Get Going. Punch two small holes through the tube at each end, about ½-in. from the ends, to anchor the ends of your coil. To do a tight, smooth and neat job of winding the coil, tie the end

Fig. 3
Crystal detector end of the Quaker Oats radio.



if your "taste" dates to earlier days, try—

RADIO

by Art Trauffer

of the wire to some object outdoors where there is plenty of room, and unwind a couple hundred feet of wire, and pull the wire tight to stretch out any bends in the wire. Cut off the wire and anchor the end in the two small holes near one end of the tube, and dab a bit of cement to hold it fast. Now wind the coil by turning the tube slowly while you walk towards the tied end of the wire, and when the tube is full of wire cut off the wire and anchor the end in the two holes at the other end of the tube and put on a dab of cement. This trick will give you a neat professional-looking coil.

As shown in the photos, the two wood end blocks for the coil measure 5 x 5 x ¾-in. and are sanded smooth, stained, and varnished. The writer's first project used oak.

Bore a 3/16-in. hole through the exact center of each wood block; these are for the length of 8-32 threaded brass rod that passes through the coil and holds the wood end blocks. One end of the threaded rod holds the U-bracket of the crystal detector (Fig. 3), and the other end of the rod serves as the antenna binding post (Fig. 2).

Note in Fig. 2 that the end of the coil nearest to the antenna binding post passes through a small hole in the wood block and is clamped between the two washers of the antenna binding post; this automatically connects the coil end to the U-bracket of the crystal detector also.

Figs. 2 & 3 give details for mounting the slide rods, the earphone Fahnestock clips, the ground binding post, and the clamp that holds the galena crystal. The simple hook-up is shown in Fig. 4. Fig. 1 gives all details for making the two sliders that will contact the coil.

Contact. Perhaps the hardest job of all is to do a neat job of removing the insulation from the coil when making the two bare wire paths for the sliders. Use fine sandpaper and be careful not to sand off too much of the copper. When you are through brush away any fine copper dust between the turns of the wire. You will get a neater job if you use enamelled wire instead of cotton-covered wire.

For best results with this crystal radio, use a long antenna, a cold water pipe ground, a sensitive galena crystal, and a sensitive high-impedance pair of magnetic earphones. ■

Your basic materials may be the same, but the bucks required to buy them have certainly bounced upward from bygone days! It cost the editor 49¢ for this box which had four different prices on the top ranging from 49 up to 55¢.

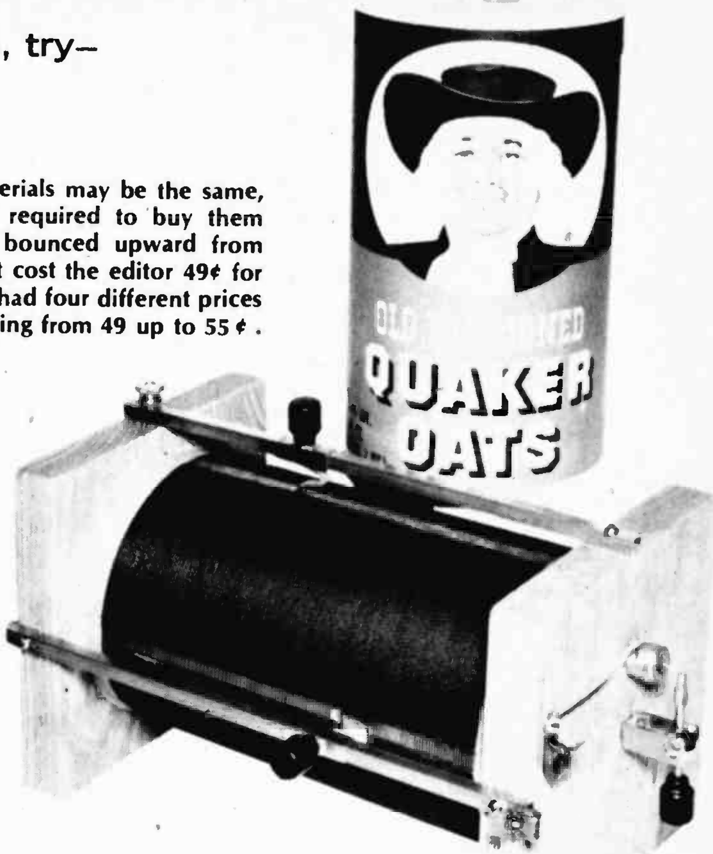
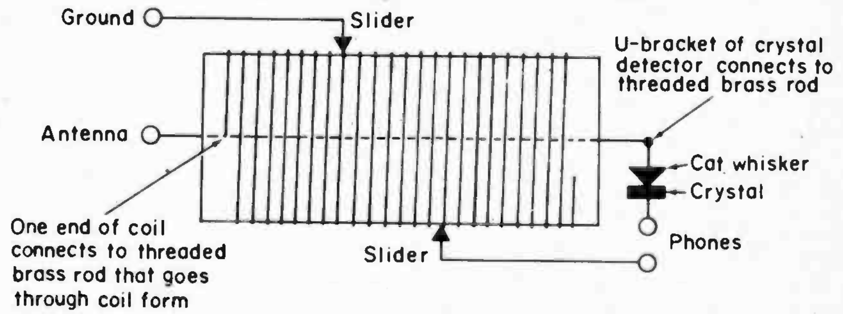


Fig. 4 Simple schematic for the crystal radio.



BILL OF MATERIALS FOR QUAKER OATS BOX CRYSTAL RADIO

1 round Quaker Oats box (18 oz.)
1 lb. #20 copper magnet wire, for winding coil (see text)
2 pieces 5-in. x 5-in. x ¾-in. oak, walnut, or mahogany (for coil end blocks)
1 foot of 8-32 threaded brass rod (to pass through coil form)
1 8-32 brass hex nut (holds crystal detector U-bracket to wood block)
2 12-in. lengths 7/32 OD square brass tubing or solid rod (for slider tracks)
3 ¾-in.-long round-head wood screws (hold brass rods to wood blocks)
1 8-32 x 1½-in. round-head brass machine screw, with hex nut and ornamental thumb nut to fit (for ground binding post)
3 inches of square brass tubing to fit snugly over slider rods (for making the two sliders)
2 6-32 x ¼-in. flat-head brass machine screws (to hold knobs to top of sliders)
3 inches ½-in.-wide brass band (for slider)
4 inches of ¼-in.-wide brass band (for making slider contact blades)
2 medium-size fahnestock clips (for phones binding posts)
1 ½-in. long flat-head wood screw (holds one fahnestock clip to wood block)
1 unmounted crystal detector stand (K/D Stand 9-14, Modern Radio Labs.)
1 mounted galena crystal for above detector stand (9-1 MRL Steel Galena, Modern Radio Labs., P.O. Box 1477, Garden Grove, CA 92642)
1 ½-in. long flat-head wood screw (holds crystal clamp to wood block)

Note: Those who do not have near-by hobby shops or large hardware stores can get most of the above hardware from MRL, P.O. Box 1477, Garden Grove, CA 92642. Send them 25¢ for a copy of their catalog.

A DX CENTRAL PROJECT...

SWL's STATION FINDER

☐ ***Tune this stable wide-band oscillator to any SWL station you want to remember; come back the next day and "zero beat" your receiver to the very same spot.***

by Charles Green, W6FFQ

SHORTWAVE BROADCASTS have been a source of interest for many years with their exotic and different forms of programs from all over the world. Many shortwave listeners (SWLs) spend many hours tuning for elusive stations on the international shortwave broadcast bands.

But, once an interesting station is found, there may be a problem in locating it the following day, if the shortwave receiver has poor dial calibration or frequency stability. Also, many receivers used by SWLs have bandspread dials which are only calibrated for the amateur radio bands—not the international shortwave bands.

Our SWL station finder project will make it easier to relocate a desired SW station on a receiver the following day. This project has an rf oscillator which is "zero beat" with the SW station's frequency, will hold the calibration, and deliver a signal close enough to the station frequency to locate the station on the following day.

This SWL station finder covers a 5 to 18 MHz range to include the most popular international shortwave bands. Construction is simplified by using a commercially wound coil and solid-state oscillator circuitry.

Perf board and push-in, clip-type construction is used for easy building. The SWL station finder is built into a compact 6¼-in. long by 3¾-in. high by 2-in. deep plastic utility box, and it requires only two penlite cells for a power supply. No connection is required to your shortwave receiver; the station finder has only to be placed close enough to the receiver for its radiated rf to be picked up.

The Circuit. The SWL station finder is essentially an rf oscillator with a hartley (grounded drain) circuit and a FET (field effect transistor) used as the oscillator (Q1). The high input resistance and low heat generation of the FET together with the large value of capacitance in the tuning circuit (L1, C1) provide low drift performance. Also, there is no rf output connection as the circuit radiates the rf signal to the receiver, thus minimizing oscillator loading.

When S1 is depressed, electrical power from B1 flows through the Q1 circuit which oscillates at a frequency in the 5 to 18 MHz range determined by the setting of C1 (which tunes L1). Capacitor C2 and R1 act as the "gate leak" which biases Q1, and C3 is the bypass capacitor which grounds the rf in the Q1 drain circuit. The Q1 source is connected to the tap on L1 that supplies the rf feedback necessary to make the circuit oscillate.

Construction Facts. The SWL station finder is built in a 6¼-in. long by 3¾-in. high by 2-in. deep plastic utility box with a metal panel. Most of the parts are mounted on a 4-in. long by 2⅝-in. wide section of perf board with push in clips, and the board is installed behind the metal panel with three ⅜-in. long metal spacers. The parts placement is critical because of the high frequency operation of the circuit, and for best performance follow our component layout and wiring placement. All of the wiring must be made with short lengths of solid hookup wire for best frequency stability.

Begin construction by mounting the vernier dial on the panel in the approximate position shown in the photos. Cut the perf board section to size and mount C1 through holes cut in the perf board (in the position shown in the photo) using three machine screws in threaded holes in the front of C1. Install a ground lug on the lower mounting screw of C1 placed on top of the perf board.

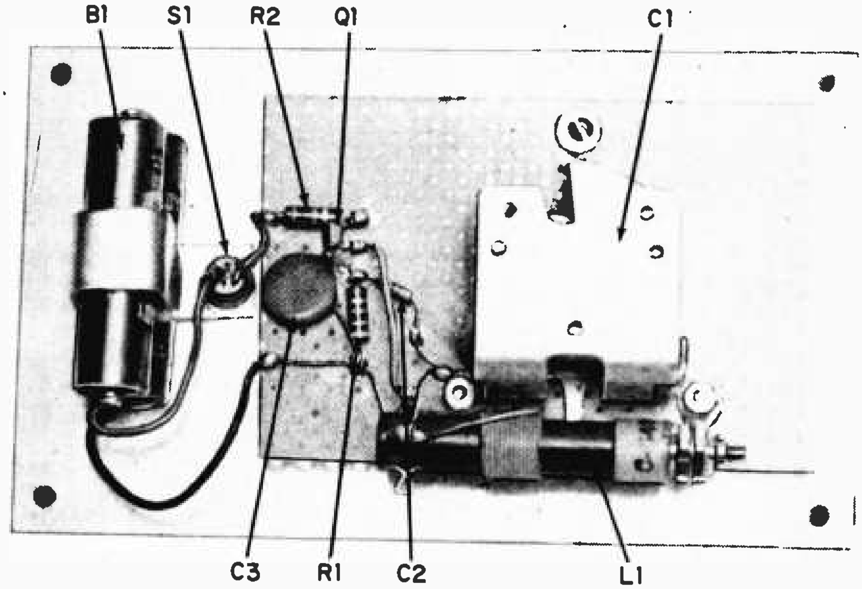
Temporarily position the shaft of C1

onto the vernier dial and locate the mounting holes for the ⅜-in. metal spacers. Remove the vernier dial and then cut the rotor shaft of C1 to the length required to fit when the ⅜-in. spacers are installed. On our model (for greater rigidity and a neater appearance) we used long machine screws for the vernier dial mounting that also fit through the ⅜-in. metal spacers and held the board. But, if this is believed too difficult, you can mount the perf board with ⅜-in. metal spacers at each corner of the board.

After the perf board is mounted, locate and cut a hole in the metal panel for S1 in the position shown in the photos. Cut a bracket from sheet aluminum to fit around the two penlite cells that are series connected to make up the 3-volt battery B1. Drill a hole in the end of the bracket to fit the mounting screw of S1. Then install S1 and the B1 bracket on the metal panel with the bracket positioned as shown in the photo.

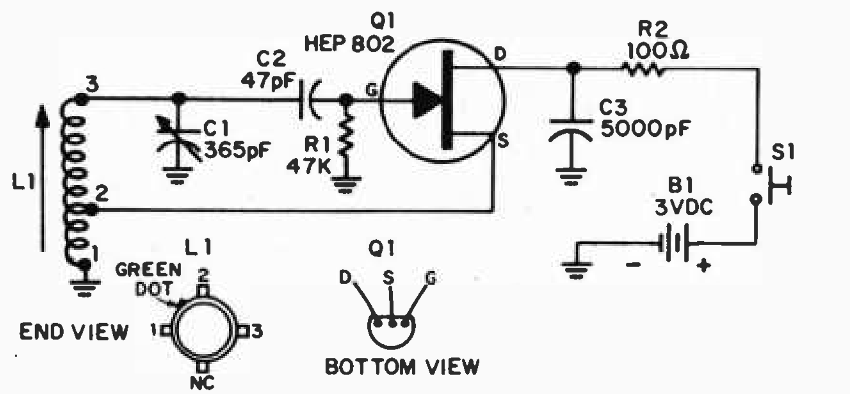
Mount L1 on the perf board parallel to the base of C1. A solder lug fitted on top of the coil with an extra nut and soldered to another solder lug mounted on the adjacent ⅜-inch spacer mounting screw keeps it in place. The other end of L1 is held by soldering pin 1 to a push-in clip on the board. Locate the L1 pin numbers by the position of the green dot on the coil form as shown in the schematic drawing.

Install Q1, R1, R2, C2 and C3 with push in clips on the perf board between S1 and C1 as shown in the photo. Position the components as in our model, and cut the leads short so that the components will remain in place without any movement for best frequency stability. Wire the rest of the circuit as shown in the schematic drawing keeping all leads as short and direct as possible.



Very simple wiring job gets you a variable frequency reference for SWLing.

Low drain circuit is powered by three AA cells. Holder can be made from scrap piece of aluminum or bought. Vernier dial has 8 to 1 turns ratio for precise adjustment.



PARTS LIST FOR STATION FINDER

B1—3-volt battery (two penlite cells in series, see text)
C1—10-pF to 365-pF variable capacitor
C2—47-pF ceramic or mica capacitor
C3—.005-uF capacitor
L1—5 MHz to 18 MHz tapped oscillator coil (J. W. Miller C-5496-C)
Q1—field effect transistor, HEP 802 (Motorola)
R1—47,000-ohms, ½-watt resistor
R2—100-ohms, ½-watt resistor
S1—spst push-button switch, momentary contact, normally open
Misc.—6¼ x 3¾ x 2-in. plastic utility box with metal cover plate (Radio Shack 270-627), 2-in. precision vernier dial, perforated board and push in clips, ⅜-in. metal spacers, hardware, wire, solder, etc.

The J. W. Miller C-5496-C coil is available from Circuit Specialists, P.O. Box 3046, Scottsdale, AZ 85257, for $3.80 postpaid.

Testing And Calibration. Calibration of the station finder is not necessary, but for convenience in tuning, you can mark the ends of the vernier dial to indicate the high frequency end (18 MHz) with C1 at *minimum* (plates unmeshed) capacity and the low frequency end (5 MHz) with C1 at *maximum* (plates meshed) capacity. Rub-on decals can be used to mark the vernier dial ends and for marking the metal panel.

Preset L1 by adjusting the tuning slug all the way into the coil (for maximum inductance), and adjust C1 for maximum capacity. Place the station finder unit near your shortwave receiver, and tune the receiver to 5 MHz. Press S1 (to *on* position) and adjust the tuning slug of L1 for maximum received signal. Place the station finder metal panel into the plastic box and it's ready for use. ●

If your shortwave receiver does not have an S meter to indicate the unmodulated carrier of the station finder,

(Continued on page 101)

IT IS A LITTLE KNOWN FACT, but the simple act of using jumper cables to start (boost) a car with a dead battery can lead to severe personal injury. It's true!

A good Samaritan in California was helping his neighbor start his car by jumping the battery. The battery exploded and our hero got a face full of sulfuric acid for his trouble. A man in Pennsylvania noticed another charging his batteryincorrectly. When he attempted to rearrange the cables from the charger there was some sparking, and the battery exploded.

The reason for both of these accidents, and many others, is the fact that a battery being charged produces hydrogen gas, a very combustible and explosive element. The longer a battery is charged the greater the accumulation of hydrogen, and the greater the danger of a serious explosion. All that is required is a single spark as one connects either of the jumper cables to a battery post.

How does one avoid such an occurrence? Simple. Just follow the step-by-step procedure given below whenever you need to jump one battery to another.

10 steps to safe battery boosting

By Thomas R. Sear

1. Ensure that the ignition switches and all electric accessories, including the lights, are turned off in both cars.

2. Verify that both batteries are rated for the same voltage. Most automotive-type batteries are 12-volt models these days; but many older cars, as well as some of the smaller models, may have a 6-volt battery.

3. Remove the dustcaps from each cell of both batteries, and make certain that the electrolyte reaches the FULL-mark. If not, ordinary tap water can be used to top-off each cell if distilled water is not available. If the dead battery is to be recharged, the dustcaps should be left off to prevent any buildup of pressure due to the rapid release of hydrogen gas from the battery fluid.

4. Cover the battery openings to prevent any splashing acid from reaching your skin or clothing. Your handkerchief will suffice.

5. Attach only one jumper cable at a time. Connect one end of the *red* jumper cable to the positive terminal of the good battery first. This is the terminal marked with a +, a P, or POS. Then connect the other end to the positive terminal of the dead battery.

6. Connect one end of the *black* jumper cable to the negative terminal of the good battery. This is the terminal marked with a —, an N, or NEG. Then connect the other end to a point on the frame of the car with the dead battery at least 18 inches from the battery.

7. Start the engine of the car with the good battery. Allow the car to warm up for a few minutes, holding engine speed to a fast idle.

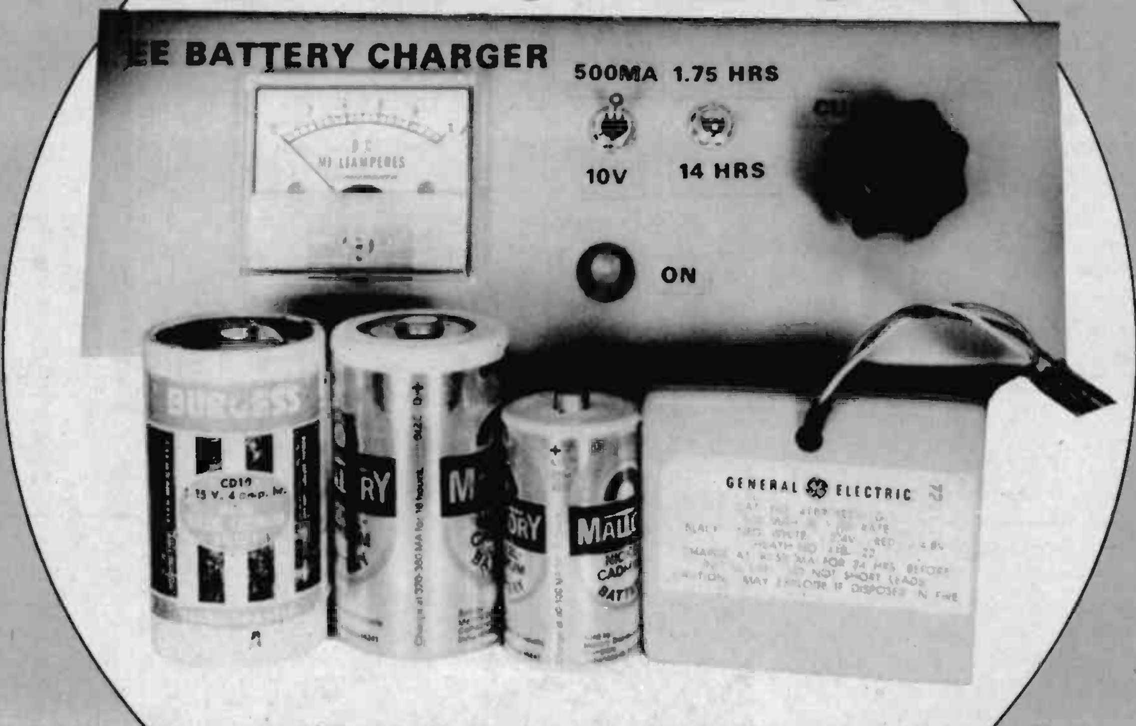
8. Start the engine of the car with the dead battery. If the engine starts, proceed to Step 9. If it doesn't, turn off the ignition and wait several minutes. Don't flood the engine with too much gasoline. If the battery is completely dead, wait about half an hour so the battery may be charged by the running car. Try to start the dead car again. Now, if successful, proceed to Step 9. If the car cannot be started, see a mechanic.

9. Disconnect the jumper cables by reversing the order in which they were connected. Keep the car with the bad battery running at a fast idle until it is warmed up. The chance of stalling is thus greatly reduced.

10. Replace the dustcaps on the dead battery.

Some final notes: It's always best to determine why the car didn't start in the first place and have the car adjusted or repaired. Repeated battery boosts are unwise and unsafe. Also, because of the hydrogen gas present when batteries are involved, *never* smoke a cigarette near a battery that is being charged. ■

SUPERCHARGER



Build this wide range NiCad battery charger with built-in automatic cut-off timer!

by C. R. Lewart

PROLIFERATION of portable electronic gadgets such as calculators, tape recorders, walkie-talkies, radios, etc., gave a big boost to sales of rechargeable batteries. This article should bring your knowledge on the rechargeable battery up-to-date and tell you about a truly universal charging circuit with an electronic timer which you can build.

Rechargeable sealed batteries, besides many other advantages, make the operation of portable equipment quite inexpensive. Do you still remember the high cost of B and filament batteries for portable tube radios? But even with transistorized equipment, the cost of "cheap" throw-away batteries may be quite high. For example, a portable calculator or a radio using four AA throw-away cells needs battery replacement about once a week if it is used for 2 to 3 hours each day. This comes to about $50 per year. A set of four rechargeable AA-size Nickel-Cadmium (NiCad) batteries costs around $8 and with proper care should last 3 to 5 years or more. The cost of electricity used for recharging comes to only about 10 cents per year. Quite a difference in cost!

What Proper Care? We mentioned that a rechargeable NiCad battery will last for many years if proper care is exercised. Our charger described in this article will give your rechargeable batteries such proper care. There are three rules to observe when handling rechargeable batteries. They are all expressed in terms of battery capacity in milliampere hours (mAh). This value is usually given by the manufacturer on the battery label. If no battery capacity is given, some common values are shown in this table. However, watch for the figures given by the manufacturer. For example, you may find a sub C cell in a D cell package.

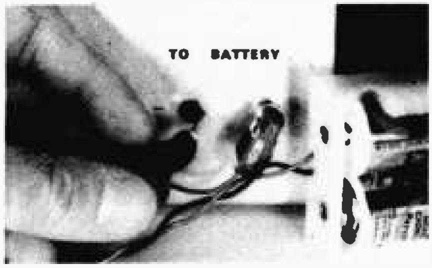
Battery Size	Capacity (mAh)	10-Hour Rate (mA)	5-Hour Rate (mA)
AA	450	45	90
sub C	1000	100	200
C	1500	150	300
D	3500	350	700

Rule 1. Do not discharge continuously at more than the hourly rate (450 mA for AA cells). Whether this rule is satisfied depends on the kind of equipment you are using. This rule will seldom be violated. Just don't try to run your electric power mower on a bunch of AA cells!

Rule 2. Do not continue discharging when the battery voltage is 0 volt (cell reversal). If you have several batteries in series, one will always have slightly smaller capacity than the others. When that battery is completely discharged, the other batteries will still pump current through it. The only way to avoid this condition is to turn off your appliance immediately when the total series battery voltage drops significantly (by more than 1 volt). You will notice it when, for example, your radio starts distorting. Turn it off immediately.

Rule 3. Do not charge at more than the 10-hour rate

SUPERCHARGER



Phone tip jacks shown here can be replaced with five way binding posts or, if you're handy enough, eliminated altogether and replaced with battery holders built right into the supercharger case. Remember, too, that you must remove the AC power cord from the AC outlet to "reset" this timer.

(45 mA for AA cells) and do not continue charging at that rate beyond full capacity for more than a few hours. Slightly higher charging rates of up to the 5-hour rate are permissible as long as the battery is still discharged. To satisfy this rule, you need to control the charging current and the charging time as is provided by this charger. Some so-called universal battery chargers put either a too-high or a too-low current into your batteries. As a result either the battery will be damaged and its life shortened or it will not get fully charged in a reasonable amount of time.

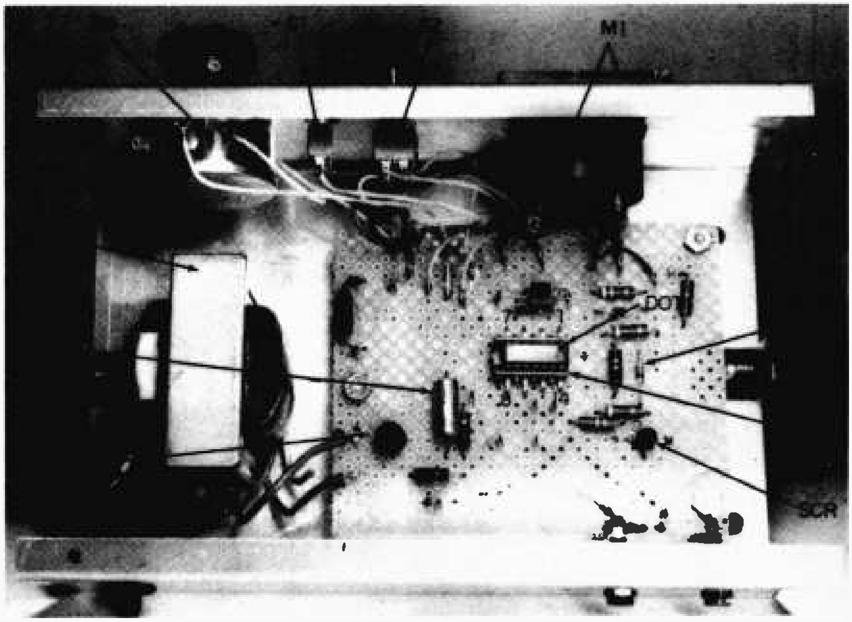
These are general and safe rules. Specially-constructed batteries (for example, the so-called quick-charge batteries) may let you break one or more of these without causing permanent damage. However, unless the battery manufacturer assures you to the contrary you better stick with our three rules; otherwise permanent damage may result. Either the battery will fail (go dead) immediately or its life-span and capacity will be shortened.

Battery Charger. This charger is capable of charging one to six cells from AA to D size. It lets you control the charging current and the charging time. You turn the charger on, set the current to the *10-hour rate* for a full charge or 5-hour rate for a quick boost, and forget it. After 14 hours (or 1¾ hours for a quick boost) the charger will turn itself off. In other words, we pump in *140 percent of battery capacity* to charge it fully (40 percent is the typical loss in the charging process). For a quick boost of 1¾ hours when the battery is completely or partially discharged, we can go up to the 5-hour rate to obtain about one-quarter full battery capacity. For special quick-charge batteries follow manufacturer's recommendations.

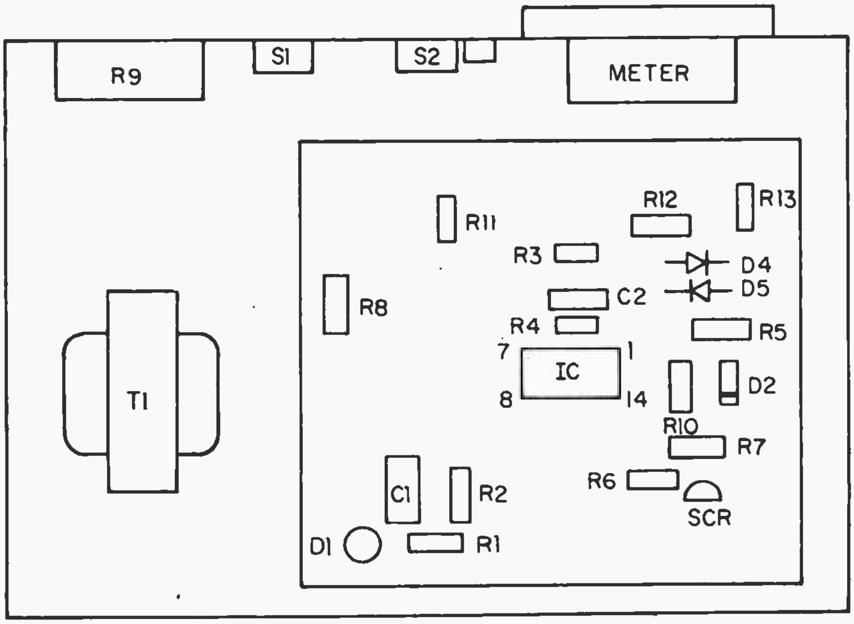
The charger makes use of a newly-developed integrated circuit which combines a built-in oscillator (similar to the 555-type) and a frequency divider of up to 65,536 (2^{16}). This way we can choose a basic oscillator frequency of 0.77 Hz which can be obtained with reasonable resistance and capacitance values and divide it by 2^{16} to obtain timing values of up to 14 hours. The basic frequency, f, is determined by C2, R3, and R4. The frequency

$$f = \frac{1}{2 \times R3 \times C2}$$

where R4 = 2 × R3. The IC is connected in such a way that the timer resets itself when the circuit is first turned on. When its timing interval is up, it will turn the SCR off permanently until the circuit is first removed from, then connected to the power line again. The rest of the circuit is straightforward. The output of the IC (pin 8) controls the gate of the SCR and lights up the LED. The charging current is controlled by the variable resistor R9. The current range with the values shown is between approximately 40 and 500 mA for up to 6 cells. Switch S1



With our photographer and artist both on the job, you should have little difficulty locating parts on your supercharger perf board. While it is possible to build this unit in a much smaller area if you wish, beginners will find the extra room a benefit.



selects the IC divider output of either 2^{16} or 2^{13}.

The lowest divider ratio the IC is capable of, 256, is particularly useful during the charger calibration. To select this counting/dividing mode, disconnect pins 12 and 13 from S1 and temporarily connect pin 12 to pin 14 and pin 13 to pin 5. When you have finished the test, reconnect pins 12 and 13 to S1 after removing your temporary connection. In this mode the timer should turn itself off after 3 minutes 17 seconds plus or minus 10 seconds. The meter M1 is used as a volt meter (0 to 10 volts) across the batteries or as a charging current milliamp meter of 0 to 500 mA. Its function is selectable with S2. The diodes D1 and D2 protect the meter from overload.

Put It Together. You can mount all components on a perfboard as shown in the photographs. The wiring is not critical. The MOS integrated circuit is internally protected against static charges, however we still recommend using a 14 pin socket. Do not insert the IC until you are (1) finished with the wiring, (2) have checked all connections, (3) and made sure the power is off.

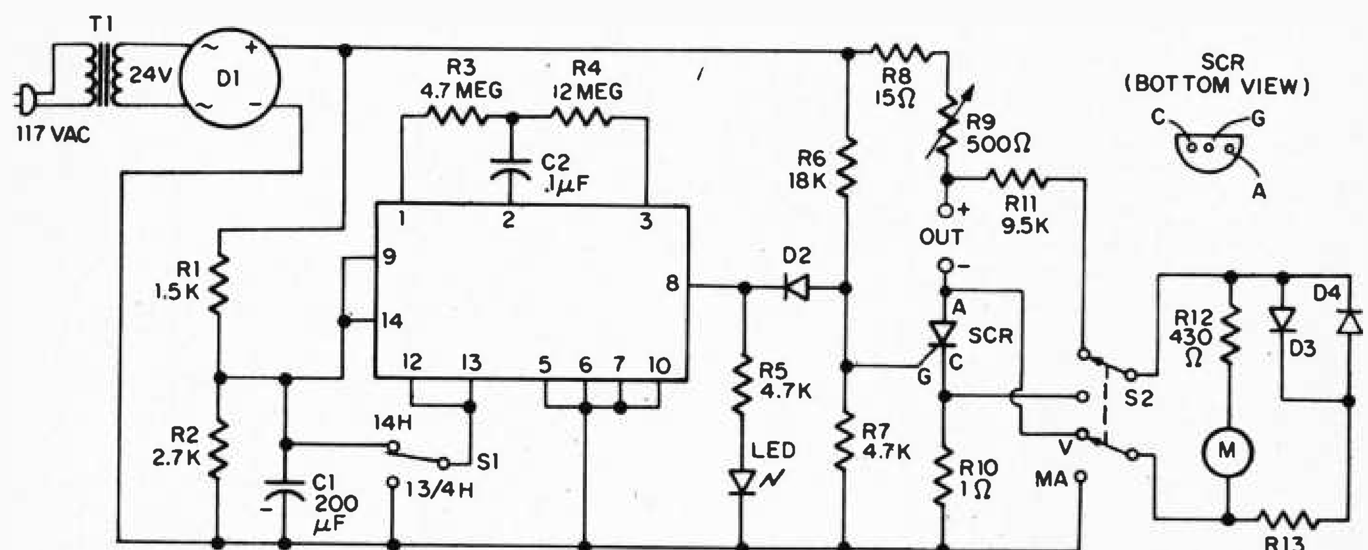
If you plan to charge the batteries outside your equipment, then you must provide battery holders for various size batteries which you want to connect to the charger. Under certain conditions, you may be able to connect the charger directly to your appliance without removing the batteries, usually via the "adapter" jack. You may have to look at the schematic of your radio or walkie-talkie to find out if the "adapter" jack is connected to batteries when a plug is inserted. If so, you can charge the NiCads in the unit.

Once construction is complete, apply power and check to see whether or not the LED pilot lamp is on. If so, it should remain on for either one and three quarters of an hour or fourteen hours, whichever time you have selected with the *time select* switch. To check the correct operation of the timing circuit in less time, you can make the following temporary connections to enable the divide by 256 function. Connect pin 12 and 13 of the IC temporarily to pins 14 and 5 respectively to select the 256 divider ratio. Try different values of capacitor C2 till you get a timing interval of approximately 3 minutes and 17 seconds. Of course, this is not a critical parameter, but it should be accurate to at least 3 minutes and 17 seconds plus and minus 30 seconds.

More Savings. Besides rechargeable batteries, regular throw-away zinc-carbon batteries can also be recharged under certain conditions. Those conditions follow.

- Battery should not be completely discharged (battery voltage should stay above 1 volt).
- Battery should not be leaking.
- Battery should be used soon after being recharged.

Other popular "throw-away" batteries are alkaline and mercury batteries. Mer-



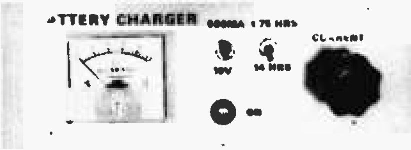
PARTS LIST FOR SUPERCHARGER

C1—200-uF electrolytic capacitor, 20-VDC or better
C2—0.1-uF capacitor, 12-VDC or better
D1—1-amp, 50-VDC bridge rectifier
D2—general purpose germanium diode such as 1N34A
D3, D4—general purpose silicon diode such as 1N914
IC1—oscillator-timer integrated circuit, Motorola MC14541CP

Note—The oscillator-timer IC, a Motorola MC14541CP, is available for $3.50 postpaid from Circuit Specialists, Box 3047, Scottsdale, AZ 85257.

LED—light emitting diode, red, 20 mA
M1—0 to 1-mA panel meter
R1—1500-ohm, ½-watt resistor
R2—2700-ohm, ½-watt resistor
R3—4.7-megohm, ½-watt resistor
R4—12-megohm, ½-watt resistor
R5, R7—4700-ohm, ½-watt resistor
R6—18,000-ohm, ½-watt resistor
R8—15-ohm, 3-watt or better resistor
Note—You can use two 7½-ohm resistors in series.
R9—500-ohm wire-wound potentiometer
R10—1-ohm, ½-watt resistor
R11—9500-ohm, ½-watt resistor, 5%
R12—430-ohm, ½-watt resistor, 5%
R13—10-ohm, ½-watt resistor
S1—spdt switch
S2—dpdt switch
SCR—0.8 to 1-amp, 100-volt silicon controlled rectifier, G.E. C103
T1—power transformer, 117-V primary to 24-V secondary @ 1 amp

Misc.—perf board, hardware, push-in clips, case approx. 6 x 4 x 3-in., 14-pin IC socket, output terminals, wire, solder, etc.



Notice there's no on-off switch. That is a function handled by the power cord. Plug it in for on—pull it out for off! Why? It's cheaper to build, for one. For another, all counter reset signals are automatically generated each time the AC power is applied. This no power switch arrangement makes it easier to operate without accidentally resetting the counter timer integrated circuit.

All commercially available nickel-cadmium batteries for consumer use will (or, certainly should) have some indication of what its charge rate and/or ampere hour rating is. The Burgess CD10 cell (far left) does not specifically mention charging rate, but its ampere hour rating is shown on the label. You can, therefore, use the rule of tumb which says charge for 14 to 16 hours at one tenth the battery rating or, in this case, 400 mA. This compares favorably with a 4 Ah Mallory cell.

cury batteries are used where high energy concentration in low volume is required. A camera or a hearing aid is a prime example of such an application. The mercury cell has three to five times the capacity of a carbon-zinc cell of the same size but it costs five to ten times as much.

Non-rechargeable alkaline batteries have about twice the capacity of a comparable carbon-zinc cell at approximately three times the price. Mercury and alkaline cells have similar nearly constant discharge voltage and low internal resistance characteristics as the NiCad cells. However, they are not leakproof and should be removed from equipment if not in use. We strongly discourage you from trying to recharge mercury or non-rechargeable alkaline batteries. Gases generated by the recharging process in the sealed cell may cause an explosion and spread the caustic electrolyte.

You may also run across rechargeable alkaline batteries. They are not as popular as NiCad batteries, but are slightly cheaper and have similar characteristics to NiCad batteries. They are not, however, as long-lived. Many other excellent types of batteries are used in military and commercial applications. They did not yet find their way to the consumer market because of high cost.

From this short description, you may deduce that the NiCad battery is the most cost-effective battery in many applications where the appliance is in *frequent* use.

On the Inside. A NiCad battery consists of layers of sintered cadmium and sintered nickel separated by fiber soaked in potassium hydroxide electrolyte.

Sintering consists of baking a powdered metal to the consistency of a solid. A sintered material is highly porous. Its active area is several hundred times larger than that of a solid plate of the same dimension. The basic chemical reaction in a NiCad battery is as follows:

Charged

Cathode Electrolyte Anode

$$Cd(OH)_2 + 2KOH + 2NiO$$

Discharged

Cathode Electrolyte Anode

$$Cd + 2KOH + 2NiOOH$$

This reaction does not generate any gases. However, during the latter part of the charging cycle, during overcharging and during high discharge, hydrogen, oxygen and electrolyte fumes are being generated. These gases will normally reach an equilibrium condition reacting with each other and with the porous electrodes. Sealed cells also have a safety venting mechanism (activated above 100 PSI) assuring that the cell will not rupture under extreme conditions. Repeated venting however, causes loss of the electrolyte and subsequent battery deterioration. For this reason controlled charging is beneficial to NiCad batteries.

Other Advantages. A major advantage of NiCad cells, in particular when used for portable radios and walkie-talkies, is a nearly constant voltage during the discharging cycle. Regular zinc-carbon batteries lose their voltage at a fairly constant rate and thus affect the performance of the equipment they are powering; however, rechargeable batteries keep their voltage nearly constant until they nearly completely discharge. For example, the voltage of a carbon zinc battery drops by approximately 0.3 volts per cell when it is 50 percent discharged. The voltage of a NiCad battery drops by only 0.1 volt during the same period. Another important feature of NiCad batteries is the low internal resistance on the order of about 30 milliohm (AA cells)—about ten times less than for a comparable zinc carbon battery. This feature is particularly important for class B type audio circuits which require more power during peaks of speech or music. Batteries with a low internal resistance can supply the sudden surges of power required for good, low distortion sound. Another important feature of NiCad batteries, as compared to zinc carbon, is that they can be stored in a charged or discharged state and are virtually leakproof.

For additional information about batteries in general and/or NiCad batteries in particular, refer to the following material. "More Staying Power for Small Batteries", *Machine Design* magazine, December 13, 1973; *Nickel-Cadmium Battery Application Engineering Handbook*, General Electric publication number GET-3148; *Nickel-Cadmium Battery Application Engineering Handbook Supplement*, General Electric publication number GET-3148-S1; *RCA Battery Manual*, RCA publication BDG-111B; *Eveready Application and Engineering Data Book*.

From flashlight to photoflood, from toys to 2-way, NiCads are in widespread use. Everyone is ready to save a buck these days; from a money-saving standpoint, NiCad batteries have some definite advantages. Maybe, if you are a heavy battery user, NiCad rechargeable batteries can help you. Why not check it out? ■

ROCK BOTTOM COST

HIGH BAND MONITOR

Getting bored by the temp-humidity index? Slide an inexpensive weather monitor up or down for some exciting signal hunting!

BECAUSE they're priced so low, generally from $10 to $20, the "weather monitor" has been a hot gift item for the electronics experimenter, so you probably have one. Tuning the weather station frequencies of 162.40 and/or 162.55 MHz, these small, inexpensive radios are supposed to keep you up to date on the latest weather conditions. But as you've probably discovered yourself, unless you're a boat owner with need for tide and sea conditions, you get a more up-to-date report from your local news station—AM or FM.

Also, reception is probably not all that great. The recommended receiver sensitivity for weather station reception is 0.6 uV for a 50-mile range, and these inexpensive weather receivers can't get anywhere near this kind of sensitivity.

But there's no need to let an unused weather receiver sit on the shelf. Fortunately, very few models use crystal control tuning, and they are easily converted to a police or fire monitor, or even a sound channel receiver for the higher VHF TV stations. But remember, there won't be any super-sensitivity. TV stations might be received some 30 or 40 miles from the transmitter, but you'll have to be within 2 miles or so of the average police or fire transmitter to pick them up. If you live near an airport you might get coverage of the aircraft frequencies above 108 MHz, but with sharply reduced sensitivity.

The weather monitors are generally similar in electronic design, though the packaging might be anything from a cube to a desk-top pen holder. The circuits are bare-minimum superhet receivers with a local oscillator tuned over a limited range by a panel control. Generally, there are two panel controls, one for *volume* and one for *fine tuning*. The fine tuning knob might have calibrations for *both* weather frequencies, or no calibration at all. It doesn't make any difference as long as the local oscillator is tunable.

To change the weather monitor tuning range, all you need do is connect a small external trimmer capacitor across the oscillator tuning capacitor—the fine tuning control. The value of capacitor will determine which frequencies are tuned. Keep in mind that as you tune lower in frequency the sensitivity is sharply reduced, particularly below about 160 MHz. A capacitor with a maximum value of 7 pF will get you down to the police/fire frequencies. A 60 pF maximum trimmer will get you about to the top of the FM band, but tuning will be extremely critical and sensitivity will be very low.

A 60 pF trimmer will also get you some of the TV sound carriers above 162 MHz. How can you receive signals above 162 MHz if the tuning range is lowered? Simple. The harmonics of the local oscillator are used to receive the TV stations. For example, if you lower the monitor's oscillator to, say, 100 MHz, the oscillator's harmonic output is also 200 MHz, and a very weak 300 MHz. (The monitor's front end appears to pass the frequencies above the design-range, 162 MHz, with greater sensitivity than lower frequencies.)

Tear It Down. To experiment you must first get the circuit out of its cabinet. Keep in mind these weather monitors are inexpensive and designed to be assembled quickly by unskilled workers. Don't go looking for tricky or difficult assembly sub-systems. Generally, one or two screws are all that's holding the cabinet together. If necessary, unsolder the speaker wires, battery wires and on-off switch wires, and remove the circuit board from the cabinet. Locate the trimmer capacitor used for the fine tuning and its two solder terminals. Solder a 3-in. length of solid, insulated wire to each terminal.

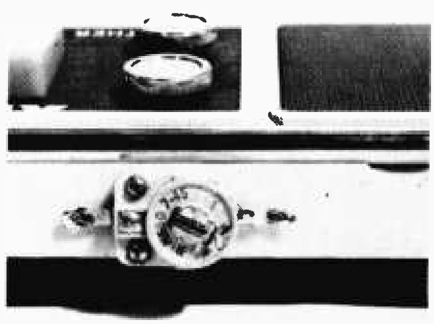
Check how the board fits the cabinet and mark the outside of the cabinet nearest the fine tuning. Drill two small holes at the mark and then install a trimmer capacitor on the cabinet near the holes. Or, you don't have to secure the trimmer if you feel you will experiment with different capacitor values, but it will be difficult to tune the stations with a "floating" trimmer. You can't hand-hold the trimmer because the capacitance from your hand will affect the tuning adjustments.

Slip the wires from the fine tuning control through the holes you've drilled in the cabinet and seat the circuit board. Then reassemble the monitor.

Connect the wires protruding through the cabinet to the trimmer capacitor using the shortest possible leads (cut off the excess).

That's the whole bit. Use an insulated alignment-type screwdriver to adjust the trimmer. You'll probably be able to tune a few TV stations immediately. Tuning police/fire calls or anything else will be more difficult because transmissions in these services are short and fast. You can preset the tuning by using a signal generator or a well calibrated grid dip oscillator.

Remember, this is a fun project. Don't hope for more than acceptable reception. But then who knows, you might be able to tune your favorite TV channel and keep track of the program while working in your shop. ■

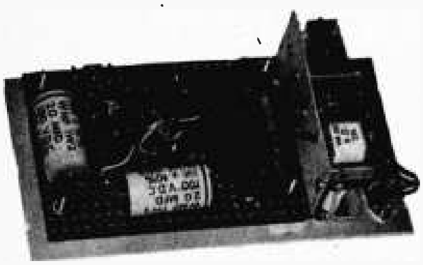


Install a small trimmer on the cabinet at a point just outside the internal trimmer.

PHOTO TIMER

(Continued from page 69)

Our amateur home darkroom includes the e/e Color Analyzer featured in the Sept.-Oct. '74 issue. It's located in the background to the right of the dry chemical (fixer) box.



Line (117 VAC) circuits and relay are placed at left side of the partition. Heavy-weight perforated board supports rotary switches S1 and S2. Timing resistors mount on switches.

some allowance for inaccuracy of timing resistors.

Put It To Work. Plug the enlarger into socket X1 and safelight into socket X2. Plug the enlarger exposure meter into socket X3. Set S5 to Focus when focusing or using the exposure meter. The safelight will now be off as is required for use with any enlarger exposure meter. To expose the print to the set time interval, switch S5 to Time and depress the start button S4. During exposure, the safelight will be off but will return automatically upon completion of the exposure. Panel lamp I3 will be on during the exposure interval. If you have inadvertently overlooked setting of the timer or lens opening and have initiated the exposure, you can terminate the exposure with return of safelights by depressing stop button S3.

By the way, photo fans, check out our B&W photo print analyzer coming soon in a future issue of e/e. It's the complement to our very popular "Darkroom Color Analyzer" project in the September-October 1974 issue of e/e. ■

FET Receiver

(Continued from page 52)

either a 3-volt DC supply or two 1½-volt dry cells in series to J2. Make sure that the positive supply lead is connected to the (+) terminal and the negative lead is connected to the (—) terminal. Plug in a pair of high impedance earphones (1000 ohms or more) to J3.

Set the volume control R7 to maximum amplitude position (fully clockwise), and adjust REGEN control R1 to mid-range. Tune C2 until you hear a station in your earphones; it may be received as a "whistle" or beat note. This is the undesired condition mentioned before and is caused by the oscillation of the gate leak detector circuit of Q1—the result of too much RF feedback. Therefore, adjust R1 until the whistle disappears and the station is heard. Retune C2 for best reception. Practice will be necessary for good results.

The most sensitive and selective point of the R1 adjustment is just below the point of oscillation. After tuning in a station, use R7 for comfortable audio volume; R1 should not be used since it reduces selectivity as well as audio volume.

Adjust the antenna trimmer C1 for best sensitivity over most of the band. This setting may have to be changed for best results at the band ends. If necessary, the value of C1 may have to be changed to a different maximum capacity to better match your particular antenna length. Also, you may have to adjust the position of the L2 tickler coil, or add or subtract turns to cover the entire band. Do not be afraid to experiment with this coil. If you do not hear any signals that "whistle," reverse the circuit connections to L2. Also, try moving the tickler coil further up L1.

Speaker operation for personal listening can be achieved with strong local stations. A 45-ohm speaker (the type that is used in intercom systems) is best for this receiver. Other lower impedances down to 8-ohms will result in lower audio volume.

A Modern Wave Trap. The regenerative type of receiver is sensitive, but since it only uses one tuned circuit (unlike a multi-stage superhet receiver), it is subject to overload by strong local radio stations. To overcome this effect back in the golden days of radio, grandad used a device called a "wave trap." This consisted of a tuned circuit in series with the antenna that attenuated the interfering station's signal and allowed weaker signals to be received.

If there is a strong local station interfering with your reception, construct a duplicate of L1 and connect it in parallel with a variable capacitor of the same value as C2 to serve as a wave trap (see drawing and photo). Tune the wave trap variable capacitor to the same frequency as the interfering station. The easy way to do this is to first tune your receiver for *maximum* received signal of the *interfering* station; then tune the wave trap (connected in series with your antenna lead) for *minimum* received signal. ■

Digital Wind Meter

(Continued from page 34)

you will have to take along a 5-volt battery supply. In order to drop the voltage to the required 5 VDC, you must connect a 2 ohm resistor in series with a 6 volt battery.

With someone else driving, take the unit in an auto on a nearly calm day and drive as steadily as possible at a certain definite speed, say 30 mph. Drive up and down a quiet road, with the wind sensor held out the window and adjust the calibration pot so the display will read an average value of 30.

Use. The wind sensor should be mounted on a roof or other location where there are few obstructions. Because of the one-shot ahead of the NAND gate, the anemometer may suddenly go blank when winds are of hurricane speed. So if the display one minute shows 75 mph and the next minute 00, don't stick your head out the window to see if something happened to the wind sensor on your roof, a tree might just be sailing by.

A simple way of checking your speedometer is to drive down an expressway at 55 and have someone time you between two mileposts. Then get your hand calculator out and divide 3600 by the number of seconds it took you to travel the mile. The result is your true speed. ■

LITERATURE LIBRARY

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

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

103. See brochures on *Regency's* 1976 line-up of CB transceivers & scanner receivers (for police, fire, weather, & other public service emergency boadcasts).

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

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

106. Get *Antenna Specialists'* catalog of latest mobile antennas, test equipment, wattmeters, accessories.

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

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

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

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

112. The *EDI (Electronic Distributors, Inc.)* catalog is updated 5 times a year. It has an index of manufacturers literally from A to X (ADC to Xcelite). Whether you want to spend 29 cents for a pilot-light socket or $699.95 for a stereo AM/FM receiver, you'll find it here.

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

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

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

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

118. CBers, *GC Electronic's* 8-page catalog offers the latest in CB accessories. There are base and mobile mikes; phone plugs; adaptors and connectors; antenna switchers and matchers; TV1 filters; automotive noise suppressor kits; SWR Power and FS meters, etc.

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

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

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

122. *Radio Shack's* 1976 catalog colorfully illustrates their complete range of kit and wired products for electronics enthusiasts—CB, ham, SWL, hi-fi, experimenter kits, batteries, tools, tubes, wire, cable, etc.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

ELECTRONICS HOBBYIST
P.O. Box 1849, G.P.O.
New York, New York 10001

Spring/Summer 1976

Please arrange to have the literature whose numbers I have circled below sent to me as soon as possible. I am enclosing 50¢ for each group of 5 to cover handling. (No stamps, please.) Allow 4-6 weeks for delivery.

Not valid after May 13, 1976

101	102	103	104	105	106	107	108	110	111	112	113
115	116	117	118	119	120	121	122	123	127	128	129
130	131	132	133	134	135	137	138	142	144	145	150
152	153	154	155	156							

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CITY **STATE** **ZIP**

Antenna Systems for SWLs

(Continued from page 87)

tuner that you can easily build is shown in Fig. 5. Details of the tuner built in a small utility box is shown in the photographs. This SWL antenna tuner can be used to improve the performance of any longwire antenna. Select the proper range for C1 with S1 and peak C1 for best S-meter output on your receiver. Fig. 6 is a photo of the completed SWL antenna tuner ready for connection to your antenna system and receiver.

Summing Up. The best antenna for you depends on the type of DX hunting you want to do and the space available. A long-wire with the antenna tuner shown will work well for general listening. If you're interested in a particular part of the work and a particular band, a single frequency dipole pointed in the right direction will give excellent results. If you want one antenna that will do as much as possible, use a multi-band antenna. In any case, those hard to log DX stations will come a lot quicker with any of these antennas, mounted as high as possible. ■

Fig. 6

Electronic Parts

(Continued from page 16)

tentiometers, mini-pots, trimmers, etc. You name it and they have it for pennies on the dollar. Just as an example, you will pay at least $1.75 for a "new" SPST mini-switch. You can buy ten brand-new SPDT mini-switches for a dollar from a surplus dealer. Many of the surplus dealers that handle odd-ball components also handle surplus manufacturer's sub-assemblies which can be easily stripped for valuable components.

You can get just about any hobbyist and/or experimenter component from the *general* surplus dealers such as Poly-Paks. A recent catalog issued by one of these dealers listed readout devices of all types, IC sockets, timers, relays, microphones, mini-motors, complete sub-chassis amplifiers, tuners and tape decks, fiber optic accessories, calculator keyboards and supplies, and even mini-computer chips.

Even some of the major electronic mail order supply houses offer big values in outdated, surplus, and oddball equipment. For example, Burstein-Applebee (known as B-A) not only has a "bargain section" in their general catalog, several times a year they put out flyers with extra special bargains in basic tape transports (such as a cartridge mechanism), meters, relays, speakers, CB transceivers, sockets, bells, gongs, wire, capacitors, etc. Similarly, Lafayette Radio also puts out several flyers a year with special bargains in experimenter and hobbyist components.

McGEE is another outfit specializing in surplus and over-runs, with particular emphasis on speakers. Get on their mailing list and you'll get offers for speakers which were formerly used in very high priced high fidelity equipment, but you'll now get them for just a few dollars. And don't overlook EDI. They handle everything from a full stereo system to parts you didn't believe existed anymore.

For the dyed-in-the-wool experimenter who believes in turning junk into gold there's Fair Radio Sales, which specializes in surplus military gear, though they often have some excellent buys in surplus industrial instrumentation such as an audio distortion meter. Much of Fair Radio's military gear can be converted to excellent civilian transmitters and receivers—often all that's needed is a power supply, and there are several "surplus conversion manuals" on the market. Fair Radio has control boxes, transformers, special microphones, and just about everything else the military used. Their catalog is another *must have* for the true experimenter.

Keep Informed. If there's a common thread that runs through "how to save money on parts" it's catalogs, catalogs, catalogs. Send away for every one you can find. Remember, one dealer's list price standard stock is another dealer's budget priced surplus. Most important, don't be afraid to order only what you need; don't add extras into your order just to make up a minimum priced order. For example, one of the best solid state device supply houses in terms of "everything is in stock" has a $25 minimum fee. Many hobbyists order unnecessary items they *think* they might need in the future (not what they *know* they will need) just to make up the minimum fee. This is throwing money out. Find some other dealer with a $1 or $5 minimum fee. Even if you must pay a handling charge of, say, 50¢ or a dollar, on small orders you're still way ahead of the game.

Our final tip on saving money is to order via UPS C.O.D. whenever possible. Stay away from the charge cards and prepayment. Here's why: A C.O.D. fee is under $1. Now consider some hard facts. Most of the mail order dealers and distributors will ship an entire order if your prepayment is a few cents under; they will send you a note asking for the small price differential. Some dealers, however, will not trust you for a penny. One or two items will be indicated as "out of stock" and you will get credit slip for what the company now owes *you*. Firstly, you might lose or never have need for the credit slip. Secondly, the component that's "out of stock" might be the most important or critical one in the entire project. Without it all your expenses might be thrown out; or, you might have to obtain the part locally at a considerably higher price. Our experience has been that, in general, you get most of what is ordered when it's shipped C.O.D.

As for charge cards, if the shipment gets lost on its way to you the bank doesn't want to know from anything; you *must* pay up. It might take you months to get a refund from the insurer, post office, or even the distributor. In one instance it took four months to trace a lost parcel. Meanwhile, you must pay the bank's charge. If you protest that you did not get your equipment the bank couldn't care less. Every billing cycle (less than one month) they will tack on a finance charge which you will end up paying. The postage you waste on letters to the bank and telephone costs protesting the interest charges will just add to your final bill. It is unfortunate that a few distributors who cause the insurance and bank charge problems are not representative of the industry. But you never know when you'll get stuck. If you've got a big order, or one involving many different components and you don't know the exact costs including shipping, it pays to have it shipped C.O.D., and UPS will be the most convenient (if you have UPS delivery in your area).

Summing Up. We can say that the way to save money on parts and projects is to take the extra few minutes to determine *who* sells *what* at the lowest possible cost, and then make certain you get everything you pay for. ■

R = Cubed

(Continued from page 76)

other end-to-end. The following intermediate values (and all their multiples of 10) are thus available: 12, 15, 18, 19, 42, 45, 48, 49, 72, 75, 78, 79, 92, 95, 98, and 99. Fig. 2 shows how the decades should be laid out on a flat piece of cardboard before assembling the cube so that the proper ends of the decades are adjacent, and the connections mate between the faces. The accompanying tables give a few examples but not all of the combinations possible) of terminal connections for obtaining different intermediate resistance values.

The cube is constructed of "artistboard" since it is inexpensive and easy to work with, but wood, plastic, or any other insulating material can be used. The mini-clips press fit into the artistboard without requiring glue or crimping, and provide convenient right-angle mounting of two resistors and a good electrical connection for the clip-leads. The cube in the photo measures two inches on a side, but could be made either larger or smaller. Measure an equal distance in from each corner and drill a 1/16-in. pilot hole for each mini-clip, push the clip in with a pair of pliers, and orient each one so that it is parallel to the others.

The cube is best laid out in two flat pieces, as shown in Fig. 2, then cut and scored, and the two pieces glued together. Each face of the cube is painted with the appropriate color-code to indicate the decimal multiplier (same as the last color band on each resistor in the decade), and the numbering is all done with press-on numbers. One or more decades can, of course, be omitted, and can always be added later if desired.

Had to Be Different. The Editor's approach to building R-Cube was similar, but we used a wooden block. Brass brads about ¾-inch long were used in place of the flea clips. Before you hammer them in place, practice on a scrap piece of wood. If all the brads were inserted at the same location on the three faces at each corner, they would meet, bend and chip the wood. A bit of offset is required. We licked the problem by hammering the brads in at an angle to avoid in-wood collision of brad points. The brads make good mechanical and electrical connections. In fact, it withstood the 10½ EEE crunch of some klutz. That's ruggedness! Build your R-Cube today, build two, build several—they beat resistor substitution boxes and stack even better. ■

SWL Station Finder

(Continued from page 91)

you can intermittently tap S1 to produce a series of CW "dashes" and then tune for the loudest "clicks" in the receiver. Or, if you have a beat frequency oscillator (BFO) on your receiver, you can adjust the BFO for a convenient audio note (as in CW code reception) and tune for best reception.

Do not place the station finder too close to the receiver, or it may overload the receiver, and result in broad tuning. Place the receiver far enough away for sharp tuning for best results. Tune the station finder from the high frequency end of the vernier dial (minimum capacity) downward and toward the lower frequency end to minimize the possibility of receiving image signals; tune for the strongest signals as heard in the receiver.

When you have found a shortwave station that you wish to listen to again, depress S1 and zero beat the station finder signal with the received station. Do not retune or disturb the station finder unit until the next day (at the correct time of reception). Tune your shortwave receiver until you hear the station finder (but first push and hold S1). You should then be able to find the desired shortwave station close to the frequency. You may have to fine tune the receiver slightly to compensate for warm-up drift of your receiver.

You can also use the station finder to transfer the tuning of a shortwave station from an uncalibrated bandspread dial to another position on the main tuning dial by zero beating the station with the station finder signal. ■

New Products

(Continued from page 10)

ranges (10-100 ohms, 100-1000 ohms, 1K-10K ohms, 100K to 1 megohm, 1 megohm to 10 megohms). Capacitance Range: 10 pfd to 1 mFd in five ranges (10-100 pFd, 100-1000 pFd, .001 to .01 mFd, .01 to .1 mFd, .1 to 1.0 mFd).

CIRCLE 23 ON READER SERVICE COUPON

Null Detector output. Two high intensity LEDs. Accuracy: Better than 5% of null dial and range switch setting. For more information, write to Continental Specialties Corporation, 44 Kendall Street, Box 1941, New Haven, CT 06509 or their West Coast office at Box 7809, San Francisco, CA 94119.

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Years of American technology and a current need to protect property, lives, and valuables have come together to produce the Gard-Site Security System, available exclusively at J.C. Penney. The Gard-Site Instrusion Detector System, a totally self-contained and radar-operated burglar alarm, incorporates principles first designed for military use and also the more current solid state and transistorized concepts. The new unit marks the first time a plug-in and install-it-yourself radar system has been available on a mass-merchandised basis. J.C. Penney is offering the complete home security system at selected large stores in major metropolitan markets. The Gard-Site unit

CIRCLE 24 ON READER SERVICE COUPON

features a battery pack back-up which operates automatically in case of power failure or electrical tampering. Other features of the system include indoor and outdoor alarm bells and time delay circuitry to allow the homeowner to enter or exit the dwelling without setting off the alarm. The unit is compact enough to store in a closet or cabinet, and it allows you to dial the range of coverage within the house. Price is $330. For more information, write to J.C. Penney Company, Inc., 1301 Avenue of the Americas, New York, NY 10019. ■

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FIRST SW ANTENNAS

(Continued from page 30)

grounding wire and ground rod. An ounce of prevention can save your home.

A dipole has some bonuses. For example, a dipole works equally as well on frequencies three times the designed frequencies. Thus, a 41-meter band dipole which will pull in 7100-7300 kHz signals will also receive 21300-21900 kHz which covers the 13-meter band. Or, if there is sufficient space to string a 195-ft. 2-in. antenna for the 120 meter band (2300-2495 kHz), then you could pull in the 120, 41 and 13-meter bands. Of course, if you want all the shortwave bands, then your best bet is a commercial dipole antenna with built-in wave traps.

Don't see much of Mort anymore except at the supermarket. Seems he's a "stay-at-home" type lately. Happy DXing, Mort.

Case No. 3—The Cave Dweller. Carl is a fun guy to know except when he's upset. For example, Carl drove over on Sunday afternoon to tell me a story he was barely capable of getting out. He had picked up a used Drake SPR-4 receiver at a fantastic price at a flea market and wanted to get involved with DXing in a hurry. It was important to Carl since he teaches French and German, and shortwave DXing would keep his foreign language skills sharp. Unfortunately, Carl lives on the 14th floor of a 24-story apartment house near the city center. His landlord, actually an agent representing the owner, refuses to let any tenant hang anything out of the windows, let alone permit Carl to install an antenna on his patio. In fact, the American flag is taboo.

I heard his sad story and told him to have his lease available when I visited him the following weekend. When I came to visit, I could see that the lease was "ironclad", so much so that it made baseball's reserve clause seem wishy-washy. That was it, no outdoor antenna for Carl.

I did make him somewhat happy by showing him an old trick. I connected the antenna lead-in wire to the metal finger stop on his phone's dialing mechanism. Reception was good considering the construction of the building, which killed reception even for parts of the AM broadcast band. This was a temporary measure since Carl was soon to get pushbutton phones.

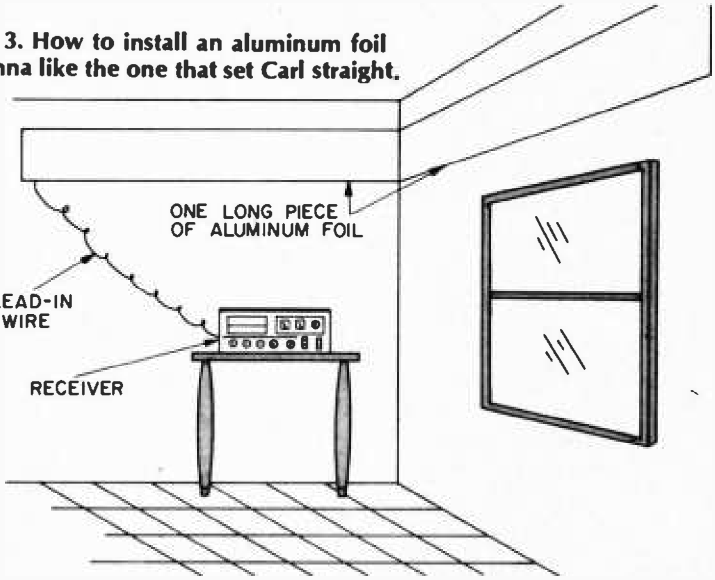

Fig. 3. How to install an aluminum foil antenna like the one that set Carl straight.

Carl was all set to return to the flea market and unload his Drake receiver. He even told me he had planned to panel his room to give the listening shack a comfortable air, but now he wouldn't. "Now just a minute, before you quit," I said to Carl, "let's give it a try." We swiped his wife's kitchen roll of wrapping aluminum and hung it on the wall with masking tape. Two walls were outside walls, so this is where we placed the foil. Fig. 3 shows what we did. It looked kind of silly until we attached a clip lead from the foil to the antenna post of the receiver. Wow! Carl practically cried as he tuned the bands. His wife practically cried too when she saw the wall but calmed down once she realized that wall panels were going up. This antenna cost only 59¢ for the aluminum foil and $45 for the wall panel job.

The last I heard from Carl was he was planning to move to the suburbs where he had purchased an old homestead on six acres. I wonder what he had in mind. ■

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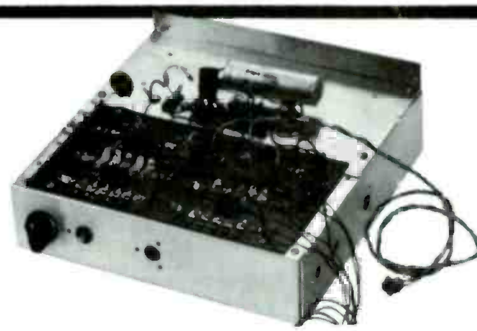

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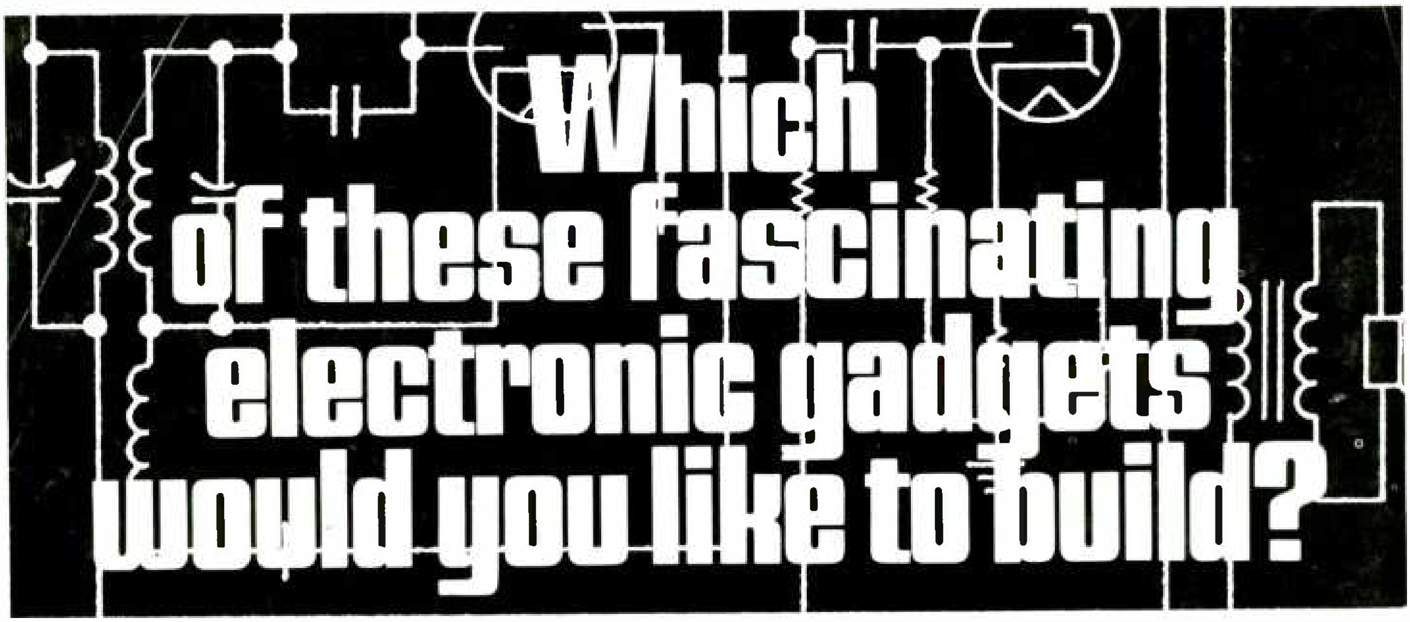

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