

# Hands-on Electronics

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JULY  
1988

THE MAGAZINE FOR THE ELECTRONICS ACTIVIST!

## Build the... 7000 Radio

We assembled it inside a gum wrapper!



## Super Breadboard

Build it to launch your new circuits into action!



## PERPETUAL CALENDAR

Simple add-on modification reveals the day of the week

## Plus—

- Long wire antennas that work!
- Battery status indicator
- Keep tabs on freezer's climate
- Rechargeable soldering iron
- Keying monitor for code buffs
- Fundamentals of magnetism



3 New FactCards This Issue







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TWK - 910-350892 DIGI KEY CORP

# 1-800-344-4539

### INTEGRATED CIRCUITS

Part	Price	Part	Price
7400 TTL	1.00	74LS00	1.00
7401	1.00	74LS01	1.00
7402	1.00	74LS02	1.00
7404	1.00	74LS04	1.00
7406	1.00	74LS06	1.00
7410	1.00	74LS10	1.00
7411	1.00	74LS11	1.00
7412	1.00	74LS12	1.00
7413	1.00	74LS13	1.00
7414	1.00	74LS14	1.00
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7497	1.00	74LS97	1.00
7498	1.00	74LS98	1.00
7499	1.00	74LS99	1.00
7500	1.00	74LS00	1.00

### MICRO

Part	Price	Part	Price
4000 CMOS	1.00	74VHC00	1.00
74VHC01	1.00	74VHC02	1.00
74VHC04	1.00	74VHC06	1.00
74VHC10	1.00	74VHC11	1.00
74VHC12	1.00	74VHC13	1.00
74VHC14	1.00	74VHC15	1.00
74VHC18	1.00	74VHC19	1.00
74VHC20	1.00	74VHC21	1.00
74VHC22	1.00	74VHC23	1.00
74VHC24	1.00	74VHC25	1.00
74VHC26	1.00	74VHC27	1.00
74VHC28	1.00	74VHC29	1.00
74VHC30	1.00	74VHC31	1.00
74VHC32	1.00	74VHC33	1.00
74VHC34	1.00	74VHC35	1.00
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74VHC38	1.00	74VHC39	1.00
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74VHC68	1.00	74VHC69	1.00
74VHC70	1.00	74VHC71	1.00
74VHC72	1.00	74VHC73	1.00
74VHC74	1.00	74VHC75	1.00
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74VHC92	1.00	74VHC93	1.00
74VHC94	1.00	74VHC95	1.00
74VHC96	1.00	74VHC97	1.00
74VHC98	1.00	74VHC99	1.00
74VHC00	1.00	74VHC00	1.00

### 5% METAL OXIDE FILM RESISTORS

Value	1/8W	1/4W	1/2W	1W	2W
10	1.00	1.00	1.00	1.00	1.00
15	1.00	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00	1.00
25	1.00	1.00	1.00	1.00	1.00
30	1.00	1.00	1.00	1.00	1.00
35	1.00	1.00	1.00	1.00	1.00
40	1.00	1.00	1.00	1.00	1.00
45	1.00	1.00	1.00	1.00	1.00
50	1.00	1.00	1.00	1.00	1.00
55	1.00	1.00	1.00	1.00	1.00
60	1.00	1.00	1.00	1.00	1.00
65	1.00	1.00	1.00	1.00	1.00
70	1.00	1.00	1.00	1.00	1.00
75	1.00	1.00	1.00	1.00	1.00
80	1.00	1.00	1.00	1.00	1.00
85	1.00	1.00	1.00	1.00	1.00
90	1.00	1.00	1.00	1.00	1.00
95	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00
150	1.00	1.00	1.00	1.00	1.00
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600	1.00	1.00	1.00	1.00	1.00
700	1.00	1.00	1.00	1.00	1.00
800	1.00	1.00	1.00	1.00	1.00
900	1.00	1.00	1.00	1.00	1.00
1000	1.00	1.00	1.00	1.00	1.00

### 1W METAL FILM RESISTORS

Value	1/8W	1/4W	1/2W	1W
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15	1.00	1.00	1.00	1.00
20	1.00	1.00	1.00	1.00
25	1.00	1.00	1.00	1.00
30	1.00	1.00	1.00	1.00
35	1.00	1.00	1.00	1.00
40	1.00	1.00	1.00	1.00
45	1.00	1.00	1.00	1.00
50	1.00	1.00	1.00	1.00
55	1.00	1.00	1.00	1.00
60	1.00	1.00	1.00	1.00
65	1.00	1.00	1.00	1.00
70	1.00	1.00	1.00	1.00
75	1.00	1.00	1.00	1.00
80	1.00	1.00	1.00	1.00
85	1.00	1.00	1.00	1.00
90	1.00	1.00	1.00	1.00
95	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00

### 5% WIREWOUND FILM RESISTORS

Value	1/8W	1/4W	1/2W	1W	2W
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70	1.00	1.00	1.00	1.00	1.00
75	1.00	1.00	1.00	1.00	1.00
80	1.00	1.00	1.00	1.00	1.00
85	1.00	1.00	1.00	1.00	1.00
90	1.00	1.00	1.00	1.00	1.00
95	1.00	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00	1.00

### DISC CAPACITORS

Value	1/8W	1/4W	1/2W	1W
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20	1.00	1.00	1.00	1.00
25	1.00	1.00	1.00	1.00
30	1.00	1.00	1.00	1.00
35	1.00	1.00	1.00	1.00
40	1.00	1.00	1.00	1.00
45	1.00	1.00	1.00	1.00
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55	1.00	1.00	1.00	1.00
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65	1.00	1.00	1.00	1.00
70	1.00	1.00	1.00	1.00
75	1.00	1.00	1.00	1.00
80	1.00	1.00	1.00	1.00
85	1.00	1.00	1.00	1.00
90	1.00	1.00	1.00	1.00
95	1.00	1.00	1.00	1.00
100	1.00	1.00	1.00	1.00

### 7400 TTL

Part	Price	Part	Price
7400	1.00	7401	1.00
7402	1.00	7403	1.00
7404	1.00	7405	1.00
7406	1.00	7407	1.00
7408	1.00	7409	1.00
7410	1.00	7411	1.00
7412	1.00	7413	1.00
7414	1.00	7415	1.00
7418	1.00	7419	1.00
7420	1.00	7421	1.00

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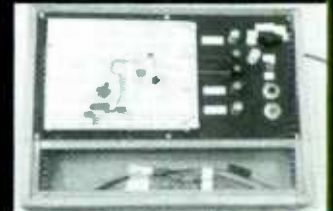
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# Hands-on Electronics®

The Magazine for the Electronics Activist!

## Desktop Publishing

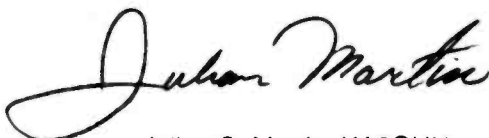
Today we hear a lot about desktop publishing. Many an entrepreneur who own a personal computer believe that they can get into the publication business and do their thing. Well, doing your thing may not be profitable or successful.

First, let's start in the *kiddie* department. I say "kiddie" with a good deal of respect. Desktop publishing programs are used at home by editors of social, fraternal, local business groups, school PTAs, etc. The combination of an editor, personal computer, and desktop publishing program has been a boon to those people and their groups. I belong to a fraternal order and I receive over 80 newsletters each month. About one-third of them are now done on personal computers. The net result is that the overall quality of the news, reporting, and format for the computer-prepared newsletters is better than other conventional methods used.

A host of new newsletter publishers and their products are now invading the market. For \$50 to \$500 you can subscribe to the knowledge and expertise of some person or group on almost any esoteric subject. At the office we are deluged with offers from newsletters purporting to be experts on finance and the stock market. Most of the newsletters are less than two years old. The overall number of newsletters prepared by desktop publishing programs is growing each day. Watch your mailbox.

I won't say anything about the role newspapers have played in the development of desktop publishing other than to mention that they are the true pioneers. What newspaper publishers have accomplished for their publications by the development of computer programming has benefited all publishers.

This magazine has enjoyed some of the benefits of desktop publishing. Of course the scope of our automated publishing activities are at a much higher level. We are not 100 percent computer generated, because our editors are engineers and experimenters first. Also, people have to be trained to do a job. It takes a minimum of four years of college and many years of hobby activities plus a few months of desktop publishing training to produce a computer-formatted hobby electronics magazine. We are going that way, but the subject matter goes *our way—your way!* Our hobby activities come first. I'm sure you want it *that way!*



Julian S. Martin, KA2GUN  
Editor

# STAFF

Volume 5, No. 7

July 1988

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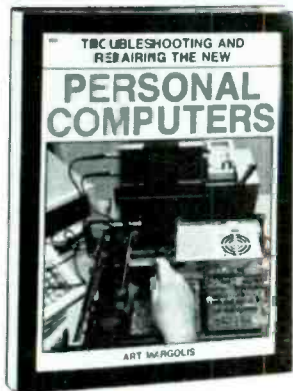
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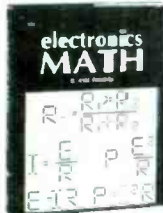
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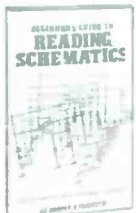
1625P \$14.95



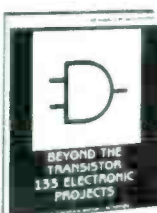
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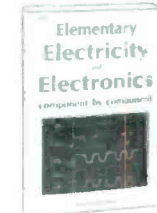
2750 \$25.95



1604 \$16.95



2861 \$14.95



2753P \$16.95



2460P \$17.95



2617 \$17.95



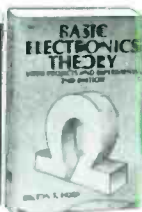
1847P \$10.95



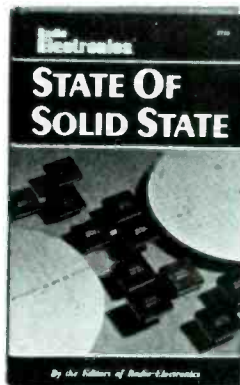
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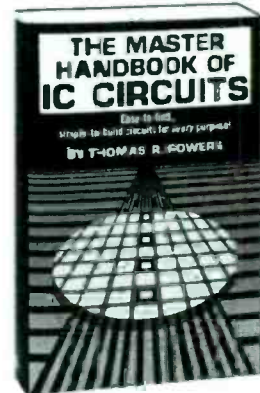


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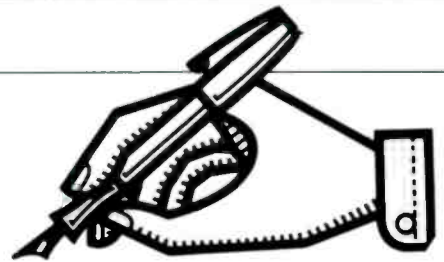
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# LETTER BOX



**Hands-on Electronics, 500B Bi-County Boulevard, Farmingdale, New York 11735**

## Supplies Surprise

This letter is written in regards to a letter in the letters column of the February, 1988 issue on page 6 from G.Y. It is not necessary to get together a \$50 order to obtain a vacuum tube.

A list of all the tubes we offer will be sent to any of your readers who send a large S.A.S.E. to Don Diers, 4276 North 50th Street, Milwaukee, WI 53216-1313.

—D.D., Milwaukee, WI

*I'm sure many of our readers would be glad to receive the four-page crammed-to-the rim listing you sent us. That's really quit a collection. Along with tubes, the company also sells hard-to-find resistors and electrolytics, just the thing to spruce up those old radios and TVs. If you've got a set laying around the house waiting for the right part, request the list.*

## Well Received

You're always asking for input from readers, so here goes. First of all I find your magazine to be just what I need. Your balanced approach to the many facets of the hobby is very nice.

I'd like to ask a favor: would you publish a construction article for a shortwave receiver? What I have in mind is a radio that could be easily built from commonly available parts. I'd like a sort of "bare bones" approach. (Perhaps changeable coils instead of a band switch—etc) I think some thing like the simple receivers of the late 40's—early 50's type only using solid state, and not too complicated. I believe many of your readers would welcome this.

Thanks for listening.  
—R.H., Guthrie, OK

*Just as I was about to reply to you, R.H., someone on the staff started taking about a shortwave receiver item just as you described. Oddly enough this letter will probably show up after that article's publication. That being the*

*case, if you don't see it in this issue, look for it in the issue preceding this one. Someone up there likes you.*

## Unfriendly Swap Meet

Please correct me if I am wrong, but regarding your March 1988 issue in the E-Z Math article. On page 76, Fig. 11 should be Fig. 15 on page 78; on page 77, Fig. 15 should be Fig. 18 on page 78; and on page 78, Fig. 18 should be Fig. 11 on page 76.

I hope you can follow that, It's a little confusing to me too.  
—W.J.D., Upland, CA

*What is more confusing is how the error got in the article, but that's an editors own personal torture. That being our problem, we're sorry if it caused you any difficulty.*

## In Training

I am constructing an "N" gauge model railroad and would like to control it with a computer. I have also considered radio control to eliminate track wiring complexity.

Any ideas you or your readers may have would be appreciated.  
—K.E.W., Scranton, PA

*I'm sure you'll get some response from the readership, as many readers have similar hobbies, model railroad-ing included. In fact most readers are interested in more than one hobby. Electronics has crept into so many other hobbies, photography for instance, that separating them is close to impossible.*

## Z-Testing P's and Q's

The best columns in your magazine are Wels' Think Tank and Rakes' Circuit Circus. However I wonder if they are proving their circuits.

I tried the speaker Z tester, page 82. March 1988 magazine and it didn't work. You hear the tone on each end of the R1 but not in the middle. The null is too wide.

I am still looking for a simple Z tester. Do you have one in your circus of circuits that will work?

—D.P., Pfafftown, NC

*Unfortunately, accuracy requires bucks. Whenever you build test equipment for yourself (yes, this means even those of you with massive amounts of experience), expect to have to compromise on accuracy. It is darn next to impossible to come close to factory-built quality on a work bench. Besides there's no warranty service available either.*

## Wiz Biz

Thank you for the very kind words describing our Disk File and Printer Manager, Disk Wiz, in the Utilities article of the February 1988 issue. We learned of the article when one of your eagle eyed readers spotted our address in the screen photos, and called in an order.

Since Disk Wiz is currently only available from us directly, we would appreciate a mention of our address and phone number so your readers can find us. The latest version (1.20) of Disk Wiz still costs \$25, plus \$3 P&H, and can be ordered from Computer Creations, 3538 Walker Ave., Memphis, TN 38111; Tel. 800/654-7684 or 901/327-9210 for those in TN.

—T.W., Memphis, TN

*We are happy to pass the address on as most of our readers have a personal computer of some sort.*

*Those of you interested in purchasing the software please mention where you saw it as the above mentioned reader did. Thank you whoever you are.*

## Metering the Readers

In your September 1987 issue, the *Digital Capacitance Meter* has me baffled. I cannot get mine to work. On page 70 under "Troubleshooting tips" first paragraph, it states you should have +5 volts at pin 6 of U3.





## LETTERBOX

*hot magazine article you (yes you) could've turned into cash upon acceptance. Just because you've got a real nice hobby doesn't mean you can't make it pay. Thanks for the tip and remember the next time you build, write about it and send the article in. If it's good we'll give you more than just a thank you!*

### We're Listening

In your January 1988 issue of **Hands-On Electronics**, I believe you made a mistake on your parts list for the "Listen in on the Tube" article.

It says that all capacitors are electrolytic, but in the picture it shows this is not so. From what I can gather there are several tantalum and epoxy capacitors in the circuit as well.

I am planning on building this project, but am puzzled. I just got started in electronics, so I'm a little rough on my knowledge. There may not be a mistake on your part, just on mine because of this.

If so please help clear up my oversight.

—K.G., Abbotsford, Canada

*You are right. Capacitors C1, C2, and C3 are polarized, but are not simply electrolytic units; they are polyester types. Capacitors C4, C5, C6, and C7 are standard electrolytics as stated in the article. Any disc capacitors can be used for C8 and C9.*

### Who's Obscene?

I cannot speak for "A.A." in Cincy, but I think your editorial comments were at a tangent to what he is trying to communicate. I, myself, think you are [censored—Ed.] I am neither an anarchist nor an admirer of offensive, crude, lewd, or stupid broadcasting. However, the FCC in its actions (Howard Stern in NYC, KZKC-TV in Kansas City, etc.) has made it plain that it does dictate programming standards. This I am 100% opposed to: this is censorship plain and simple.

By what standard shall the FCC dictate what may and may not be broadcast? "Community standards?" Who determines which community sets the standards? A community of snake worshippers might declare Lawrence Welk "obscene."

As Vladimir Zworykin, the inventor of CRT-based television, once said: "The television has an 'off' switch." If I deem

a given program offensive, I switch it off. However, although I can always turn the set off or change channels, I cannot watch what is not broadcast in the first place. That is where the FCC is at fault. Its spectrum-allocating and license-issuing policies (as apart from its censorship) are equally evil, in that not only can I not watch what is "obscene", I cannot watch anything not broadcast by a large and well-funded organization.

I do not advocate abolishing the FCC. I do advocate (1) restricting it solely to the issuance of licenses and maintenance of technical standards, and (2) forcing it to make available sufficient numbers of licenses, so that those who wish to broadcast on a profitmaking basis can do so.

The shortwave broadcast bands, and at least 15 MHz in the 400-600 MHz region, should be opened to domestic clear channel (SSB?), and community (or local, under 1 kw—but for-profit) use respectively. If that means stepping on foreign propaganda broadcasting, or hams, tough. In the meantime, the "pirates" are doing the only thing possible, at their personal expense. I am happy to see them do it and look forward to listening in.

—J.M.C., Lenexa, KS

*Unfortunately, J.M.C., while we wanted your opinion to be published as is, we had to censor a very small portion of it. It was censored not because we find your opinion totally disagreeable or offensive, but because of the way you stated it.*

*Simply put, we want readers' opinions on everything, just put it in a language that we all can share without embarrassment. We feel we owe that to our readership, not because we wish to set community standards, but we are sensitive to those whose standards may be better than ours. Maybe that should be the FCC motto.*

### 2nd Class Info

In the February 1988 issue of **Hands-On Electronics**, you talked about how to get the General Radiotelephone operator's license. I would like to know how you can get the 2nd Class Radiotelegraph Operator's License, and which books are recommended. Thank you for your cooperation.

—J.M., Fresno, CA

*I'm afraid I have some disappointing*

*news for you. After calling the FCC examiner in New York City, and Mr. Langley in Washington, DC., the Public Service Division of the FCC, I was told by both that there is no 2nd Class Radiotelegraph study guide that's in print. The reason being that so few people take the exam that it is not profitable for a publisher to print and distribute a study guide.*

*FCC Bulletin FO-7 regarding application procedures and eligibility requirements for the Radiotelegraph Operator's Certificates may help you. I suggest you go to your neighborhood library and ask them to research out-of-print books on the 2nd Class Radiotelegraph examination. You're more than likely to come up empty-handed and frustrated.*

*Unless you absolutely require that license for your job, I suggest you concentrate on the GROL, as outlined in the article.*

*Nevertheless, I wish you all the best if you decide to go ahead and attempt the Radiotelegraph examination. Maybe you could pass your 2nd Class Radiotelegraph exam and write an article about how you did it for publication in **Hands-On Electronics**.*

### Kit and Kaboodle

I really enjoy your magazine, but I wish you would talk of more projects from commercial kits. Also if you would review what new kits are on the market it would be helpful too.

The reason I am pushing for kits is that they are self contained and I believe their instructions are more detailed; they take you by the hand and lead you through the construction.

In your February issue you had a very good article on a power supply, but for a novice to build it, he would have to have knowledge of circuit boards, etc. While the kits are not that sophisticated.

Please see your way to talk about kits too.

—J.V., Tacoma, WA

*We're with you! We want to see more kit projects in the magazine. We also want more people to write about their kit-construction experiences. Let's face it, we want a lot so we can give you a lot. By the way, have you ever thought about being the author of that much-desired article? Unfortunately, Santa only comes once a year, but by being an author you can give and receive at the same time, while filling that eleven-month gap. ■*



# History

## Out of the Word Processor

By Nelson



"Our hero, to be sure, was a handsome, one-legged pirate called Long John."



"He was looking for the Fountain of Youth and only discovered silicon chips."



"In my day a writer used a sharpened quill dipped in a mixture of soot and oil."



"Quoth the black raven, 'Word processor, word processor, word processor!'"



"No I don't want any more stats on how many times the crew's been seasick!"



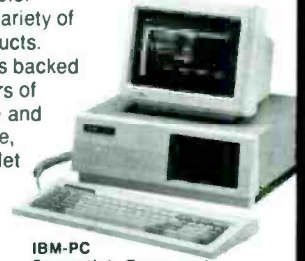
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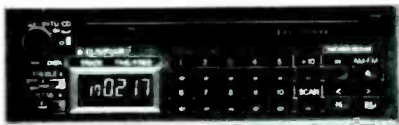
CIRCLE 11 ON FREE INFORMATION CARD

# NEW PRODUCTS

## CD Tuner

Blaupunkt's new CD Tuner, the Chicago SCD 08, combines a high-quality, AM/FM tuner with a cartridge-loading, CD player for quality highway sound. The Chicago SCD 08 was designed around Blaupunkt's proprietary *UniFit* installation system which makes the Chicago look like it was factory installed, and provides the option of using a Quick-Out removable mounting for theft deterrence.

The Chicago's cartridge-loading system, which uses the same cartridge as was used on the earlier CDP 05, protects CD's from damage and makes them much easier and safer to use in the car. The CD-cartridge case has a small opening that is covered by a sliding door. The door only opens when the disc is inserted in the player, keeping the disc free of dirt, grease and scratches.



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The Chicago's CD mechanism uses a three-beam laser for optimum disc tracking on bumpy roads. Other CD features include direct-access play of up to 99 track selections, scan (plays 10 seconds of each track), fast forward/reverse, pause, and play.

The Chicago uses Blaupunkt's ORC II tuning system for sound quality and multi-path distortion rejection. In weak signal conditions the signal blends gradually from stereo to mono to maintain optimum reception. Tuning accuracy is assured by a phase-locked loop (PLL) digital synthesis system for easy manual seek and scan tuning. The tuner circuitry is housed in a compact, external enclosure. A non-volatile, preset memory can store 10 FM and 10 AM stations and has a last-station memory feature. The LCD display is easy to read at any time of day or night.

The Chicago features preamplifier

outputs, with a built-in fader, separate bass and treble, balance and volume controls.

The Blaupunkt Chicago SCD 08 carries a suggested retail price of \$799.95. For further information write to Blaupunkt, P.O. Box 4601, North Suburban, IL 60198.

## Radar Detector New Design

Bel-Tronics, the maker of the Profile Series 3 line of radar detectors claim twice the range and sensitivity of previous units. In addition to incorporating Image Rejection Technology (IRT) the unit is capable of sensing and sounding an alert to the new Ka-band of police radar currently in use or under evaluation in parts of the United States.

The raked front panel has four control buttons situated beneath 8 LEDs that give alert status. A blue button placed at the left corner is an on/off switch and the cluster of three buttons on the right side offer convenience features. One button allows the driver to engage an audio-mute circuit which will automatically mute the audio signal after an initial alert is sounded. The visual alert indication remains in effect. The second button operates a false signal recognition (FSR) circuit which recognizes and eliminates unwanted X-

band alerts, but has an override feature which maintains audible and visual alerts for K and Ka-bands. The third button mutes the LEDs for discrete and undistracted nighttime driving.

Above the button cluster are five red LEDs which function as a signal strength meter—the first LED flashes green to indicate *power on* and then flashes a *red alert* when a weak signal is received, and as the signal gets stronger, more red LEDs flash.



CIRCLE 87 ON FREE INFORMATION CARD

The single amber and two red LEDs on the left side provide the visual 3-band alert signals. Amber indicates an X-band signal, while K and the new Ka-band each have a red LED. Also, the Express 3 detector unit sounds distinctly different audible-alert signals for each band, and has a different audible alert to identify pulsed or "instant-on" radar. A volume control permits the driver to set the volume of the audible-alert signal. The new model also has an audio jack for an external speaker.

The Express 3 detector incorporates computer controlled superheterodyne circuitry, as well as a gallium-arsenide (GaAs) diode and surface-mount technology. The Express 3 also incorporates Rashid VRSS rejection circuitry which eliminates the false K-band alert sometimes triggered by the collision warning system.

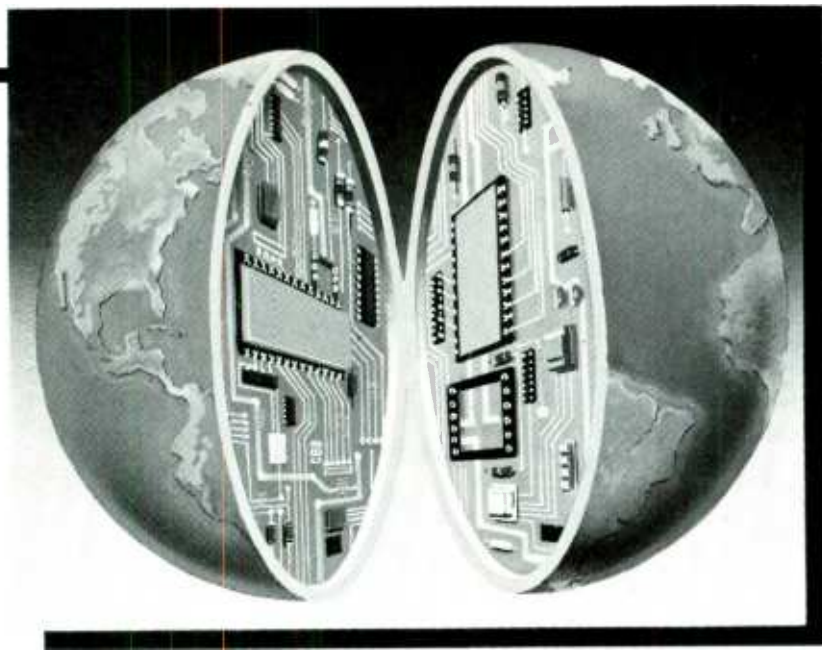
The unit comes with an accessory package including visor and windshield brackets, hook-and-loop fastener, 6-foot coiled power cord, 9-foot straight power cord, protective travel case. The Bel-Tronics Express 3 measures 2<sup>3</sup>/<sub>4</sub>-in. wide by 5-in. deep by 1-in. high; it weighs

(Continued on page 12)



"Uh-oh! Looks like we're in for trouble!"





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CIRCLE 5 ON FREE INFORMATION CARD

## NEW PRODUCTS

(Continued from page 8)

6.8 oz.; it has a suggested retail price off \$339.95. For information, contact Bel-Tronics Limited, 2422 Dunwin Drive, Mississauga, Ontario, Canada L5L 1J9.

### Programmable Remote Control

The *Marantz RC-20 Programmable Remote Control* combines 60 commands for ease in controlling an audio system, VCR and television set. The three-source unit is consumer-designed specifically for ease of use.

The RC-20's front panel is slanted and the large white legends, which describe each function, contrast boldly with the unit's black/gray panel. The most used function keys are strategically



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placed so that fingers naturally fall on these commands. The volume up/down control and mute, for instance, are located on the top row; fast-forward and pause are on the outer right-hand column. The control measures 7-3/4-in. wide, 4-1/2-in. deep and 1-1/2-in. high.

The RC-20 features all the functions commonly used for audio and video. Located on the left hand-side of the panel



"When you said you were assembling a clone I thought you were talking about a computer."

are the audio commands, including POWER ON/OFF, VOLUME UP/DOWN, MUTE, INPUT SELECTION, STATION PRESETS OF CD PROGRAMMABILITY, transport controls and TAPE PAUSE. On the right-hand side are the VCR controls: POWER ON/OFF, PLAY, PAUSE, STOP, RECORD, REWIND, FAST-FORWARD and SLOW MOTION. And in the center are the TV functions: POWER ON/OFF, VOLUME UP/DOWN, MUTE, and STATION PRESET. There also is an option key which can be programmed for any function the user wishes. Marantz is offering customers an optional "how to program your remote" videotape to get your RC-20 up and running.

The RC-20 remote control carries a suggested retail of \$99.95. For more information contact Marantz Company, Inc., 20525 Nordhoff Street, Chatsworth, CA 91311; Tel. 818/998-9333.

### Soundfield Loudspeakers

The dbx SF 2500 is designed for budget-minded consumers, with a retail price of \$500 per pair. It features a 6 1/2" woofer, 2 1/2" midrange and two 1/2" tweeters. Construction is similar to the other new Soundfield models, as are the Soundfield Imaging properties.

The technique used, developed and patented by dbx, provides a major improvement in the spatial perspective of music reproduction in the home.



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Soundfield Imaging loudspeakers create a sonic image with a realistic breadth and depth of field that is identical for virtually any listening position in front of the speaker pair.

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extremely broad listening area, a listener does not have to sit midway between two speakers to experience proper tonal balance and satisfactory stereo imaging.

For additional information contact dbx, Consumer Products, PO Box 100C, Newton, Mass 02195.

### Lens Accessories

The *RCA Camcorder Special Effects Lens Kit, Model AC029*, consists of four 52-mm optical-quality filters that attach to the lens and create visual effects to add interest and creativity to video recordings!

The center-focus filter gives sharp focus to the center of the picture and softness to the edges for a vignette effect; the rainbow filter creates a multi-colored halo around a bright spot in the picture; the four-point starburst filter adds gleams of light to bright spots; and the polarizing filter reduces glare caused by reflections, while it darkens and enriches blue skies to produce spectacular cloud backgrounds.

The kit also includes step-ring adapters that connect 52-mm filters to 46-mm and 49-mm lenses on all makes of camcorders. The kit has an optional retail price off \$59.95.



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Camcorder Lens Care Kits, Models AC026 and AC027, help keep lenses clean and clear for sharp video images. The filters allow the full light of the spectrum through to the camcorder while protecting the lens from dust, scratches and cracks.

A 46-mm (Kit AC026 only) high-quality optical-grade skylight 1A lens filter fits RCA camcorder models CLR200, CMR200, CPR100, and CPR250. A 52-mm (Kit AC027 only) high-quality optical-grade skylight 1A lens filter fits RCA camcorder models CMR300, CPR300, CPR350 and other camcorders with 52-mm lenses.

Each kit also contains a rubber blower brush and special non-abrasive lens-cleaning fluid with soft tissues. The retail price for the kits is \$9.95 each.

The RCA Lens Adapter Holder Model LAH001 is an essential accessory for expanding the use of most RCA VHS-C camcorders through the use of auxiliary lenses. It is designed to fit RCA VHS-C camcorders (except CPR-100) to permit them to accommodate adapters for wide-angle, telescopic and other auxiliary lenses. The adapter holder snaps in front of the camcorder lens and has a convenient pushbutton release. The optional adapter holder sells for \$16.95.

The Special Effects Lens Kit, the Lens Care Kits, and the Lens Adapter Holder are available through RCA Video Accessories distributors. For further information contact Sales Promotion Services, Deptford, NJ 08096.

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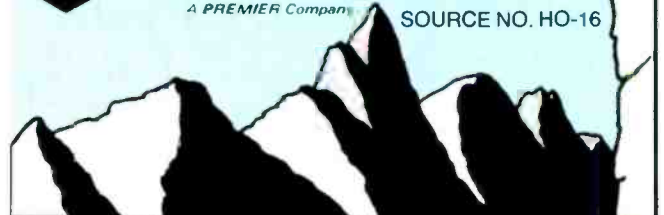
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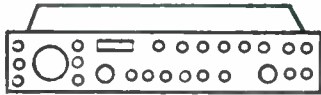


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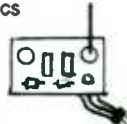


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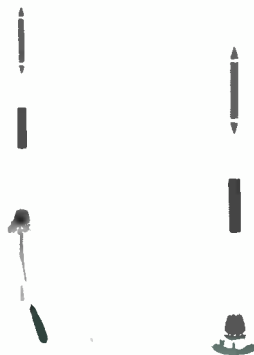
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## NEW PRODUCTS

### All-Band Scanner Antennas

All-band scanner antennas that provide enhanced performance up to 1000 MHz are now available from The Antenna Specialists Company. Models MON-52 (mobile) and MON-58 (base station) feature *Micro-Choke*, an exclusive Specialists development that provides pinpoint resonance at 800-MHz scanning frequencies and concentrated beam focus at low radiation angles for maximum-range monitoring. The enhanced 800-MHz performance will al-



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low scanners to pick up police, fire, and other emergency communications operating on those frequencies with much less distortion than conventional all-band antennas. The antennas offer coverage from 25-1000 MHz with excellent performance at low and high VHF ranges and the UHF bands, and are manufactured of professional-grade materials. The mobile version has a no holes, quick-grip, trunk-lid mount for easy installation and includes coaxial cable with installed pin plug. The base-station antenna offers easy one-clamp installation. For more information contact: The Antenna Specialists Co., 30500 Bruce Industrial Parkway, Cleveland, OH 44139-3996; Tel. 216/349-8400.

### PS/2 Floppy Drive

Matchmaker PS/2 compatible, floppy drive provides an efficient and economical solution to the problem of porting software and data from existing IBM and IBM compatible personal computers to the new PS/2 machines. The drive mates with all models from the Model



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25 to the Model 80.

PS/2 machines may run programs directly from the Matchmaker, or programs may be copied from the Matchmaker to the PS/2-system hard disk or internal 3.5-inch floppy disk drive, for later use by the PS/2.

The Matchmaker has a formatted capacity of 360 KB and an average access time of 81 mS. It weighs in at 3.9 lb., it measures 2-in. high by 6-in. wide by 10-in. deep. The Matchmaker operates with IBM PC-DOS 3.2 or higher and carries a one year warranty.

For further information contact Dolphin Systems, 603-B E. Alton Ave., Santa Ana, CA 92705; Tel. 714/546-6938.

### Super Probe

The *AR-100 Maxi-Probe* is really three instruments in one. First, an auto-ranging DMM that measures DC or AC voltage and resistance. Second, a full-featured logic probe that works with both TTL and CMOS logic up to 10 MHz. Finally, it's an audible continuity checker.



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The Maxi-Probe may also be used with screw-on accessory tips, such as alligator and spring-hook types, which are available separately.

The "Data Hold" feature is standard, allowing users to capture and hold a



voltage or resistance measurement. The unit also boasts a diode-test feature, for reading the forward-voltage drop of a rectifier, and a removable ground lead, to further expand versatility and ease storage requirements.

The AR-100 Maxi-Probe comes equipped with an alligator clip ground lead, a set of logic test leads, a carrying case, and an operator's manual. The AR-100 sells for a suggested retail price of \$64.95.

For further information contact ARI Media, 9241 E. Valley Boulevard, Suite 201, Rosemead, CA 91770; Tel. 818/287-8400.

### Car Audio System

The CP-3 Car Audio System by Jensen offers the CS-1000 AM/FM car stereo cassette receiver packaged with a pair of 6-1/2-in. dual-cone car speakers. The receiver features electronic tuning, with digital LED readout and phase lock loop (PLL) circuitry for precise, drift-free reception.



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The receiver has 10 station presets (five AM and five FM) and seek tuning, which advances to the next strongest station at the touch of a button. The tape deck section of the CS-1000 features auto reverse, locking fast-forward,



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and a tape-direction indicator.

The companion speaker system consists of a pair of 6-1/2-in. dual-cone speakers with frequency response of 75 Hz to 18 kHz, and peak-power handling of 40 watts. The units have a shallow mounting depth for easy installation.

Combo Pack System CP-3 has a suggested retail price of \$159.95. For more information contact International Jensen, 4163 N. United Parkway, Schiller Park, IL 60176.

### Computer Interface Remote

When connected to a personal computer, the *Revox B203 Timer Controller* allows for virtually total automation of the Revox Series 200 music system. Components can include the B285 receiver, B286 tuner/preamplifier, B226 CD player, and B215 cassette deck.

The optional software package for the B203 interface, which is compatible with any MS-DOS (fully IBM compatible) home or personal computer, makes programming for automated operation truly simple. The B205 remote control module makes remote operation an easy one-touch operation. The Revox components are easily connected to the B203 interface, while its RS232 port allows simple computer hookup.



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The optional B203 software package prompts the user and creates a series of commands from the prompts, for effortless programming and the ultimate in automated operation. Almost all functions and transport operations can be programmed. The computer automatically checks the audio equipment to determine whether commands are being executed and completed. Musical entertainment for an entire evening can be programmed, with random access to CD tracks and cassette segments.

Additional time-programming options include programming by single date and time as well as programming by day of the week and time. Single date and time allows for programming a one-

(Continued on page 100)

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# BOOKSHELF

## The Basic Guide to VHF/UHF Ham Radio

By Edward M. Noll

This new volume provides a down-to-earth basic introduction to amateur radio operating on the 2-, 6-, and 1.25-meter bands as well as 23-, 33- and 70-cm.



Ham Publications

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Interest in those frequency ranges is growing rapidly, especially with recently authorized operations by other classes of operators in those bands. The book provides essential information for the novice, new technician, higher-grade licensee and the about-to-be ham interested in joining the action on the VHF and UHF frequencies.

The book presents a clear and easily understood look at VHF/UHF equipment, antennas, operating techniques, repeaters, contesting, and awards. Band plans for each of the VHF/UHF bands are also included.

The Basic Guide to VHF/UHF Ham Radio is must reading for anyone planning operation on those frequencies or just recently active in those ranges.

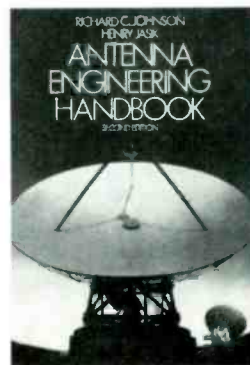
The Basic Guide to VHF/UHF Ham Radio, contains 86 pages costing \$6.95 plus \$1 shipping (\$2 foreign) from Tire Publications, PO Box 493, Lake Geneva, WI 53147.

## Antenna Engineering Handbook By Richard C. Johnson and Henry Jasik

Turn to this Handbook when you want reliable data on the characteristics of a particular type of antenna; when you

need to know its operating requirements when used for a specific application, or when you need practical help on checking out impedance, gain, radiation patterns, and other antenna properties.

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reference gives you the guidance you need to solve the perplexing problems that might arise in antenna design and application.

The Antenna Engineering Handbook contains 1408 pages and costs \$110 from McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020.

## Digital Electronics Troubleshooting—2nd Edition By Joseph J. Carr

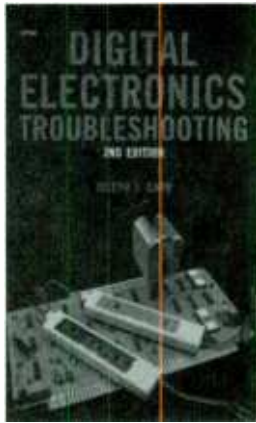
This book covers not only the basics of digital circuitry found in the first edition, but also several forms of clock circuits, including oscillators and multivibrators, and the latest microprocessors used in cassette players, VCRs, TVs, and other consumer products.

One of the features that has made *Digital Electronics Troubleshooting*—



2nd Edition so popular over the years is its easy-to-follow, classroom approach—logical, step-by-step presentation, with problems and answers to help readers test their own progress. Adding to its effectiveness are more than 300 illustrations, schematic diagrams, and charts that make digital electronics concepts easy to grasp.

After the gentle introduction to digital electronics, Author Carr provides in-depth explanation of number systems, digital codes, digital IC logic families,



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logic gates, and arithmetic circuits. More advanced subjects follow, such as clocked and un-clocked flip-flops, digital counters, registers, timers and multivibrators, data multiplexers and selectors, and digital clocks. Finally, the book covers data conversion, microcomputer interfacing, test equipment, and much more in its 434 pages.

Joseph J. Carr is well known for his amateur radio column that appears in **Hands-on Electronics** and the countless magazine articles he has had published throughout the years in this and other leading hobby-electronics magazines.

*Digital Electronics Troubleshooting—2nd Edition* (order No. 2750) costs \$17.60. It is available from TAB Books, Inc., P.O. Box 40, Blue Ridge Summit, PA 17214, or telephone 717/794-2191.

### 33 Fun-And-Easy Weekend Electronics Projects By Andres Guzman, NSEAJ

Even radio amateur novices can build test equipment, telephones, alarms, receivers, and transmitters. Amateur ra-

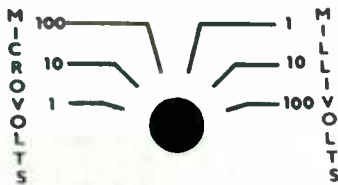


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dio operators (techs and up) will be especially interested in Author Guzman's receiver and transmitter projects, and others such as a broadband RF amplifier and four different TTL oscillator circuits.

Every project that requires one is provided with printed-circuit board layouts. And there is also enough information for readers who want to prepare printed-circuit boards by themselves. Projects for the auto workshop, electronics workbench, and ham shack are included. And by using integrated circuits, readers can

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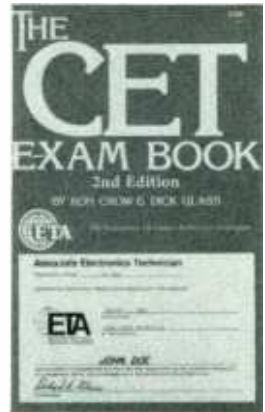
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### The CET Exam Book—2nd Edition By Ron Crow and Dick Glass

*The CET Exam Book—2nd Edition* is a source for technicians needing to update or review basic skills and for anyone who simply wants to explore electronics as a hobby. More important, this book is also the complete study guide for anyone preparing to take the CET exam. Passing the Associated-level Certified Electronics Technician exam is a prerequisite to taking the Journeyman-level test in an electronics specialty.

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*The CET Exam Book—2nd Edition* contains 280 pages. The paperback edition (order No. 2950) sells for \$13.60 and can be bought from TAB Books, Inc., P.O. Box 40, Blue Ridge Summit, PA 17214, or telephone 717/794-2191.

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Microsoft Word is an extremely powerful and flexible word-processing program for IBM and compatible personal computers. Que's *Using Microsoft Word—2nd Ed.*, is an informative guide to both basic word-editing procedures and advanced Word techniques. The book features numerous ready-to-use style sheets, a handy troubleshooting section, and information on features new to Word 4.

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(Continued on page 22)



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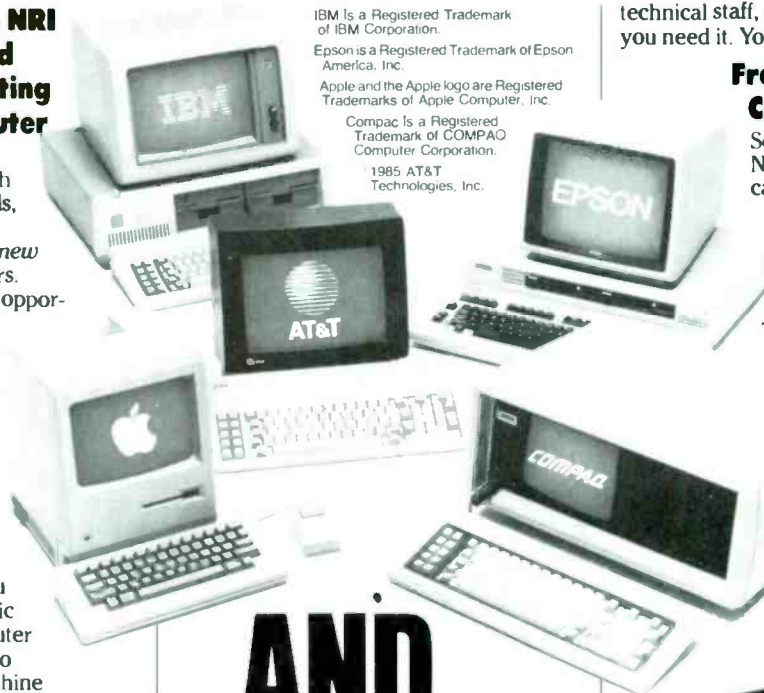
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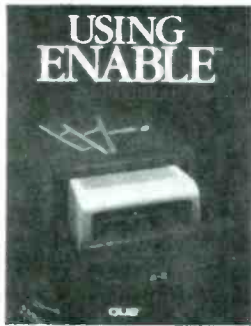
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(Continued from page 18)



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### Micro Interfacing Circuits— Book 2 By S.J. Wainright

This book is intended to carry on from where Book 1 left off. It is primarily concerned with practical applications beyond the parallel or serial interface to the microprocessor. It is about "real



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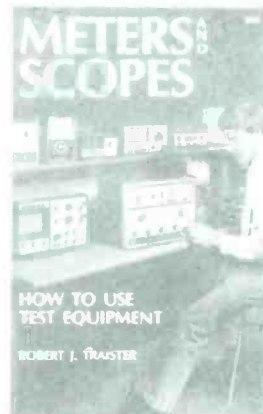
world" interfacing including such topics as sound and speech generators, temperature and optical sensors, motor controllers etc.

Like Book 1, the subject is not treated in a purely theoretical manner. Practical circuits using real devices are provided together with detailed circuit descriptions and any relevant background information so that, it is hoped, anyone with a reasonable knowledge of electronics should have little difficulty in using or adapting the circuits for their own particular applications.

The book contains 88 pages and costs \$5.75 from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

### Meters and Scopes: How to Use Test Equipment By Robert J. Traister

Today's test instruments are user-oriented. While their internal functions may be difficult to understand, most are relatively simple to operate and will provide highly accurate test measurements. This book was written to dispel the mystery that has unjustifiably surrounded electronic testing and open a new world of experimentation, use, and repair to the electronics hobbyist.



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This book is both an introduction to electronic measurements and test instruments for beginners and a good reference for practicing technicians. Robert J. Traister clearly describes the function and use of various test instruments, along with exactly how to connect these devices to electronic circuits under test.

Several chapters discuss the nature of measurement, its history, and the various systems now in use. Readers will find in these first chapters good discussions of basic electronic components and concepts. One unusual chapter outlines a logical, six-point method of trouble-

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troubleshooting that can be applied in many situations. This chapter includes many helpful hints on how to locate and diagnose problems, such as short-circuits and burned-out resistors.

Following these early chapters is the real heart of the book, which describes specific test instruments and their use. Beginning with the simplest test instruments, such as the dc voltmeter, ohmmeter, and ammeter, Traister completely explains what each device is for and exactly how to use it.

Other devices covered: the multimeter, a versatile device that combines many different instruments into one; the basic oscilloscope, including its many components, controls, and uses; and the dual-trace oscilloscope, a very important part of any technician's electronic tool-kit.

Two chapters of particular interest to more advanced electronics technicians cover transmitter and antenna measurements and audio equipment instrumentation and measurements—including all of the associated special purpose testing devices. Finally, Traister describes how to buy test instruments that fit readers' needs. The book is fully indexed for easy reference.

*Meters and Scopes: How To Use Test Equipment*, order No. 2826, costs \$14.60. Containing 322 pages, it is available from Tab Books Inc., P.O. Box 40, Blue Ridge Summit, PA 17294-0850; Tel. 717/794-2191.

### Basic & Forth in Parallel By S.J. Wainright

Forth is a very different type of language from Basic, and has a different philosophy of program development. However, despite the differences, this book takes both languages together and investigates how things are done in each



### CIRCLE 97 ON FREE INFORMATION CARD

of them; Basic being used as a familiar "handle" with which to grasp the various programming techniques available in both languages.

The Forth-stack simulator which is presented at the end of the book, will run on either a 16K or 48K Sinclair Spectrum, and will enable the user to visualize what happens on the stack, when the various stack operator words are used. The stack is central to the operation of Forth, and an understanding of the stack and the stack-like effects of Forth words, is fundamental to an understanding of the Forth programming language.

An essential addition to the bookshelves of all computer enthusiasts who want to learn Forth, the book contains 95 pages, costs \$5.00, and is available from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

### Troubleshooting with the Oscilloscope

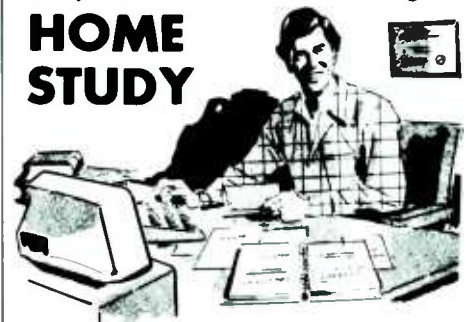
By Robert Middleton

This 225-page book will help technicians and hobbyists obtain the maximum benefits from the wide selection of scopes now available for servicing and repair.

This step-by-step guide will advise readers of the latest advancements in technology and show them how to use the oscilloscope efficiently to increase profits by performing diagnostic tests and repairs more quickly than possible before. The new edition emphasizes digital troubleshooting and applications as well as the time- and data-domain analyzers and the logic-state analyzer. There's also up-to-date information about television receiver troubleshooting using modern oscilloscopes.

Topics covered include: introduction to the oscilloscope, how to operate an oscilloscope, using oscilloscope probes,

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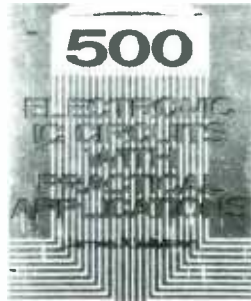
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Power supplies, voltage regulators, and other circuits that are common to many different types of electronic devices are covered in the first chapter, along with battery chargers, peak detectors, converters, and filters. The remaining chapters examine the circuits associated with specific applications, such as: amplifier circuits, especially the op-amp (the most commonly used type of IC amplifier device), oscillator circuits, including timers, count-



CIRCLE 98 ON FREE INFORMATION CARD

ers, clocks, and multiplier and divider circuits, interfacing circuits: analog-to-digital and digital-to-analog, digital electronics and microprocessor-based circuits, optoelectronic circuits, with coverage of remote-control devices and display drivers, audio, radio, and video circuits, including some interesting cellular radio circuits, alarms and safety/security circuits, one-of-a-kind circuits like an automatic battery back-up switch or triac-controlled temperature regulator.

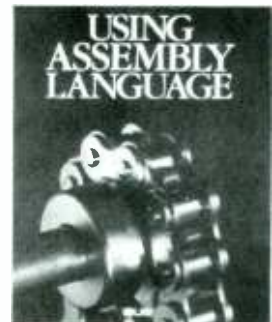
The book is organized logically, and is extensively cross-referenced, making it an ideal reference for hobbyists and professional technicians alike. Also, it provides more complete information about different types of electronic components than other circuit books, rather than just page after page of circuit dia-

grams. Nor does the book contain specific projects—instead, it gives readers the kind of complete information they need to be able to design their own customized electronics projects.

*500 Electronic IC Circuits With Practical Applications* containing 352 pages, costs \$18.60. It can be purchased from Tab Books Inc., P.O. Box 40, Blue Ridge Summit, PA 17414; Tel. 717/794-2191.

## Using Assembly Language Allen Wyatt

Assembly language subroutines can eliminate the limitations and inefficiencies that are sometimes part of high-level programming languages like BASIC, Pascal, and C. Que's book, *Using Assembly Language*, shows programmers how to make the most of their programs with assembly language subroutines. Functioning as both a learning aid and a reference guide, this excellent book demonstrates how to harness the speed, versatility, flexibility, and code compaction that is possible with assembly language.



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Using Assembly Language helps programmers understand assembly language instructions, commands, and functions—how they are used and what effects they produce. Teaching through example, the authoritative text shows readers how to: interface assembly language with BASIC, Pascal, and C, develop and manage object file libraries of subroutines, manipulate video memory and access hardware ports, successfully debug assembly language subroutines, and how to access BIOS and DOS services. Costing \$22.95 and containing 700 pages, *Using Assembly Language* can be found in most book and computer stores. To order directly from Que, call 800/428-5331 and ask for a sales representative. ■



"This oughta be good—I just switched Club 21's menu with McDonalds."





# LIGHT UP YOUR DAYS WITH A PERPETUAL CALENDAR

**T**HIS DAY-LITES CIRCUIT COUNTS 60-HZ DC SIGNALS from a time clock and drives seven LEDs that indicate what day of the week it is. It may be added to the three common types of LED clocks: those that display time only, those that alternately display time and date, those that display time and have a push switch to display date.

Days are continuously indicated in each case without inhibiting normal clock functions. In the last case a perpetual calendar that always shows Day, Month, and Date is made by adding a toggle switch in parallel with the calendar push switch. That application, and the use of Cosmo-Time E-909 Clock-Calendar, is detailed here. The clock is reasonably priced at K-Mart and other stores. Other clocks may be used if the user makes appropriate modifications to the data presented.

## Functioning

Figure 1 is the schematic diagram of the unit. The 60-Hz signals taken from the clock are input to U1, a 4017 signal

division chip. Integrated circuits U1, U2 and U3 divide their inputs by 6, 10 and 100, respectively. U4 divides its input by 864 and gates U5-a when the designated U4 outputs are simultaneously high, which occurs once a day.

The negative signal from U5-a is inverted by U5-b; that positive signal resets U4 and clocks U6. The designated outputs of U6 are sequentially taken high and drive one LED each day.

A one-shot/debounce circuit (consisting of U7, S1, etc) permits manual selection of the appropriate LED at start-up. Temporarily closing S1 produces a half-second signal that resets U4 and advances U6 outputs to illuminate the desired LED. To ensure timely LED turn-on in the future, selection should be made soon after midnight; LEDs will then advance at the same time every 24 hours.

The 60 Hz signals are also used to strobe-bias Q1, and their absence during a power failure keeps Q1 in the off state. A backup-battery powers the clock, but blanks the display during an AC power failure to conserve the battery.

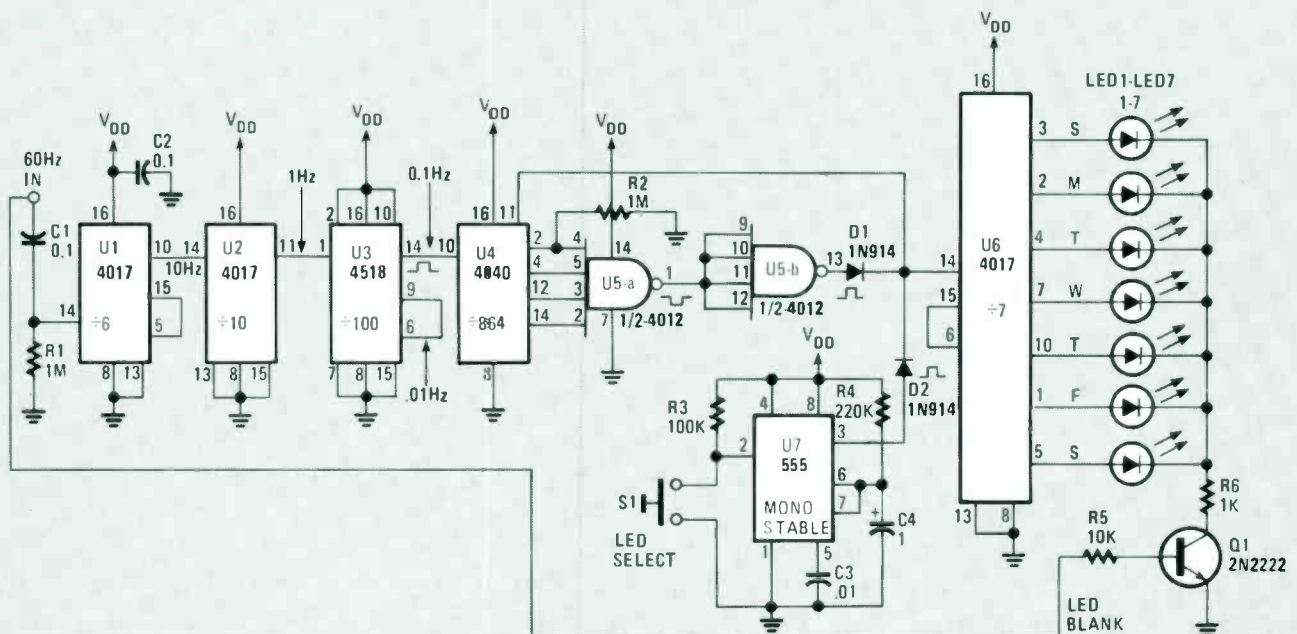


Fig. 1—The 60-Hz input signal goes through four divisions before being gated out.



## Add the Day-Lites perpetual-calendar circuit to any LED clock and keep track of the days of the week as well as the time!

By Paul W. Aman

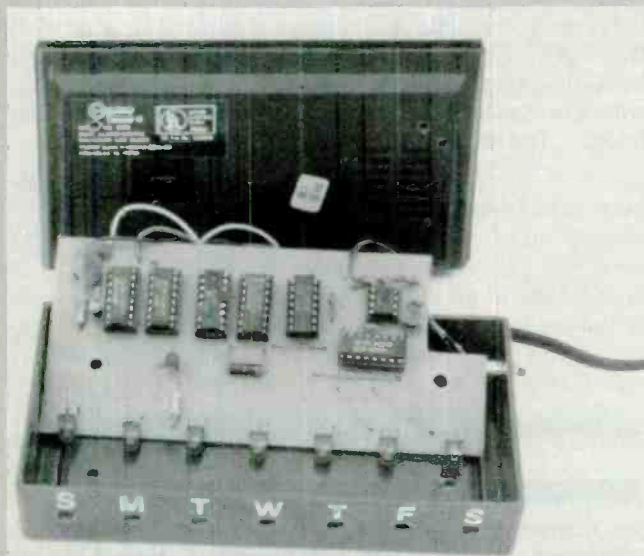
When no signals are input to U1, the count in the Day-Lites circuit freezes, and LED advancement is delayed for the power failure period. R1 protects the U1 input and R2 ensures glitch-free outputs by U4. D1 and D2 isolate the One-shot circuit from the counter circuit except during manual LED selection. C2 suppresses any supply-voltage spikes and, since only one LED is lit at any time, only one series resistor (R6) is required.

### Circuit Board

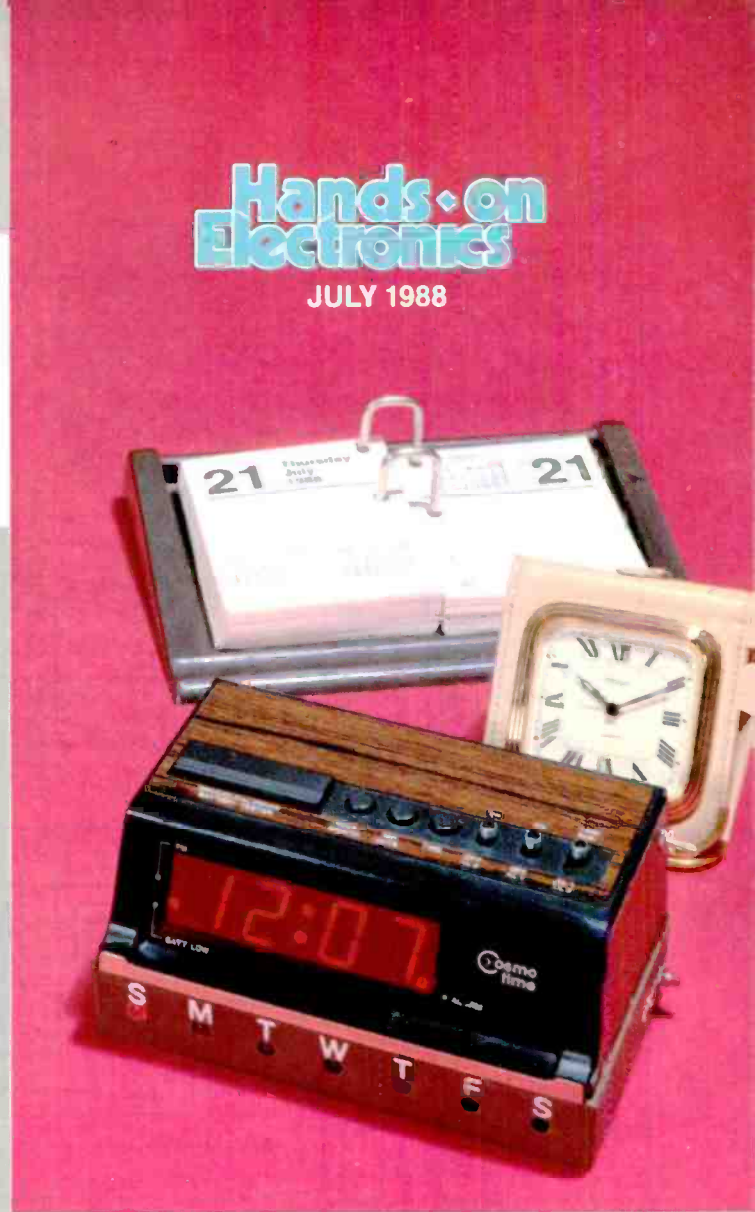
Figure 2 shows component placement and an Xray view of the PC. Figure 3 is an actual-scale PC plan that may easily be converted to an actual PC using the dry-transfer doughnuts, traces and IC pad patterns listed as components. When the PC has been etched and checked for errors, mount the components beginning with the component-side jumpers.

### Day-Lites Enclosure

Figures 5 and 6 are sketches of the Cosmo-clock and the Day-Lites case which is made from the cover of a plastic 3" x 5" index card file box. Select a box that has flat, rather



The PC Board allows you to pack the parts neatly beneath the clock case. The LEDs leads are kept short for strong mounting.



than sculptured, sides to permit proper LED exposure and labeling. Other purchased or constructed boxes that fit the bottom of the clock may be used.

If you wish to use an index box cover, start by cutting the cover hinge and trimming it flush with the cover edges. Cut away any protrusions inside the cover to 1/4" or more below rim.

Carefully locate and bore holes for the LEDs and S1. Affix letters above LED holes and label S1 hole DAY. Self-adhering plastic letters are preferred and are available at Office-Supply stores. Dry-transfer letters may be used if protected by a clear spray.

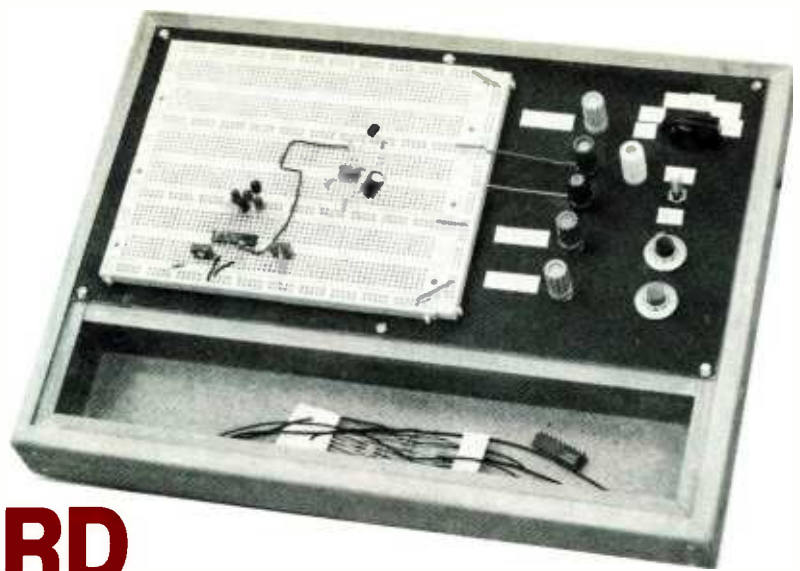
### Cosmo-Time

The bottom of the clock case is beveled and should be notched as in Fig. 5 for a snug fit into the Day-Lites case. Notch the front and rear, not the ends of the clock case.

Referring to Figs. 4, 5, and 6 prepare the clock as follows: Remove both AC and battery power. Remove one screw and pry the bottom from the case. Slide the joined display and circuit board from the case, leaving the 10-conductor cable in place.

Locate the five connecting points shown in Fig. 4 and carefully solder color-coded wires to them. Bore a hole in a

# BUILD THE SUPER BREADBOARD



**Build this super launch pad for your integrated-circuit design ideas in just a couple of hours of your time**

**By W. Schopp**

**A**LMOST ANYONE WHO DOES EXPERIMENTAL WORK using IC's or transistors has some sort of solderless breadboard lying around for whipping up circuit ideas. Usually it is a plug strip requiring an external power supply. If an additional circuit such as a single-pulse or clock-pulse generator is required, it usually has to be breadboarded on the same circuit, or connected to an external pulse generator. That usually requires a lot of additional time and effort, especially if it's only required to test or operate the actual circuit being designed.

The *Super Breadboard* can give you all the features found only in the most expensive prototyping boards. Best of all, you can design it with your own needs and requirements in mind.

## Features

The Super Breadboard can be built using the strips salvaged from an existing less-expensive breadboard, or built up to your own configuration using new strips available from any electronic parts supply. By making the base board larger and adding a power supply, positive and negative push-button activated pulser, and a variable-frequency, clock-pulse generator, life suddenly gets easier for launching those new and exotic circuits. Other options such as a negative power supply or anything else that strikes your fancy can be added at the expense of more jacks, switches, and a larger base board.

The Super Breadboard has a power supply that supplies either 5 volts for working with TTL, or 15 volts for working with all CMOS circuits.

## Current Measurement

The positive power-supply leg (see Fig. 1) has a one-ohm series resistance built-in so that the current drain for your particular circuit can be quickly calculated by measuring the voltage drop across the resistance. Since the resistance is one ohm, the current is easily calculated using ohms law which states the current is found by dividing the voltage drop that

appears across the resistance by the resistance which is always one. ( $I = E/R$  or  $I$ ). Simply stated, the voltage obtained across that resistance can be read directly as current in amps.

## The Board and Supplies

The board shown uses 3, 6½-in. long component strips, 4, 6½-in. supply strips, and a 5⅞-in. supply strip across the top to tie in all the other supply strips. The strips were salvaged from an old board, and your own layout can be modified to suit your individual needs.

The base board can be cut from ¼-in. aluminum sheet. Since the base is not electrically part of the board, it can also be made from ⅛-in. hardboard.

The unit shown uses a packaged 15-volt power supply which was salvaged from another piece of obsolete equipment. It was easier to use it than to build one from scratch. The 15-volt supply is used for CMOS and a 5-volt regulator adjusts this voltage down to the voltage requirements for TTL chips.

The voltage selection switch is wired in such a way that when it is in the center position, the AC voltage to the power supplies is turned off.

The power supplies are obtainable in many sizes and shapes and often can be found just lying around in your junk drawer waiting for a project like this to be put to use. If you don't have one lying around, you can build your own or use the kit listed in the parts list. Most of the supplies are plus and minus 15 volts and, if needed, the minus 15-volt lead can be brought out by adding another terminal to the top of the base board.

## Pulsing

The bounceless push buttons that supply positive or negative pulses and the clock generator are all built on a small piece of PC board. The PC pattern is shown in Fig. 2.



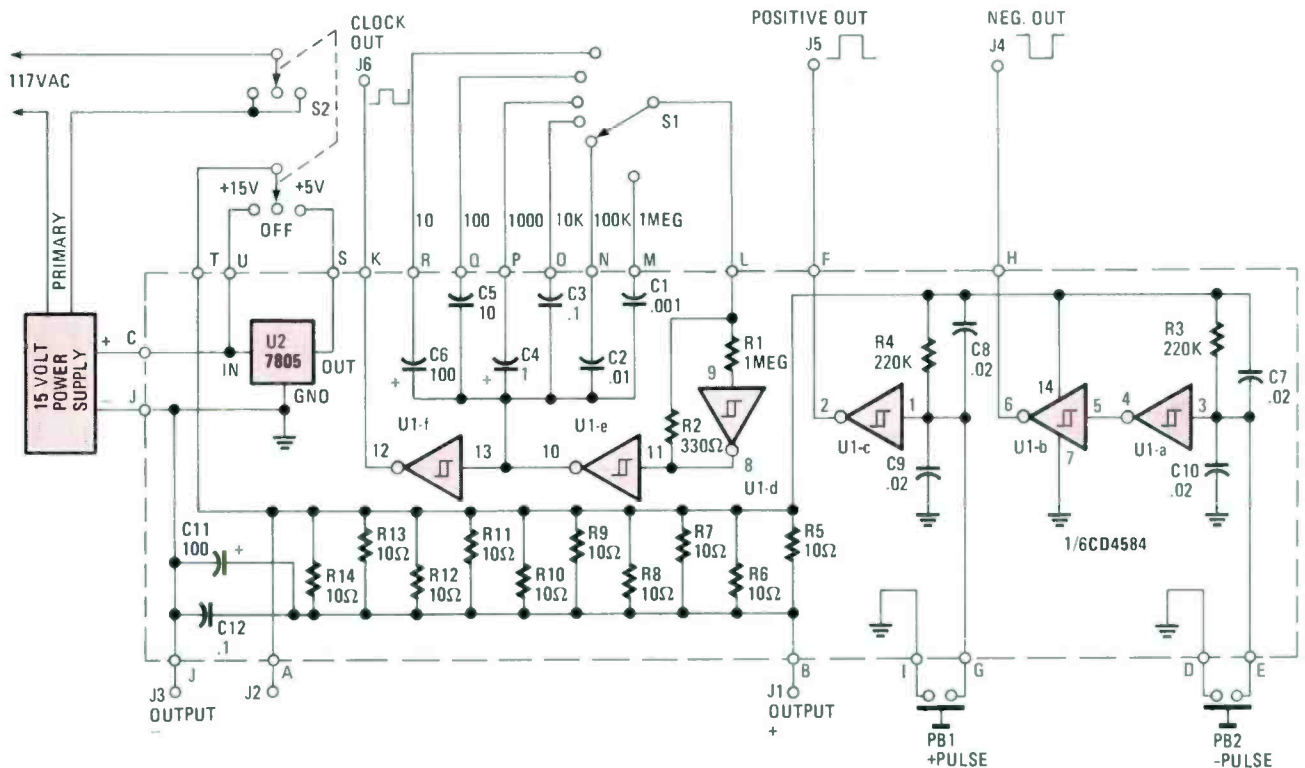


Fig. 1—The letters denote jump off points on the printed-circuit board, although one is not necessary. The output current for the device can be measured as voltage across J2 and J1 as resistors R5–R14 resolve to 1-ohm.

### PARTS LIST FOR THE SUPER BREADBOARD

#### CAPACITORS

- C1—0.001- $\mu$ F, 50-WVDC
- C2—.01- $\mu$ F, 50-WVDC
- C3, C12—.1- $\mu$ F, 50-WVDC
- C4—1- $\mu$ F, Tantalum
- C5—10- $\mu$ F, 16-WVDC
- C6, C11—100- $\mu$ F, 16-WVDC
- C7, C8, C9, C10—.02- $\mu$ F, ceramic disc

#### RESISTORS

- (All resistors are 1/4-watt, 5% precision units.)
- R1—1-megohm
  - R2—330-ohm
  - R3, R4—220,000-ohm
  - R5–R10—10-ohm

#### ADDITIONAL PARTS AND MATERIALS

- J1–J6—Banana jacks
- PB1, PB2—Normally open, push-button switch
- SW1—SP, 6-position, rotary switch
- SW2—DPDT, center-off, toggle switch
- U1—CD4584, Inverting, hex, Schmitt-trigger, integrated circuit
- U2—7805, 5-volt regulator, integrated circuit

A  $\pm$  15-volt power supply is available from Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002; Tel. 415/592-2503.

Breadboards can be purchased from Digi-Key Corp., PO Box 677, Thief River Falls, MN 56701-0677; Tel. 800/344-4539.

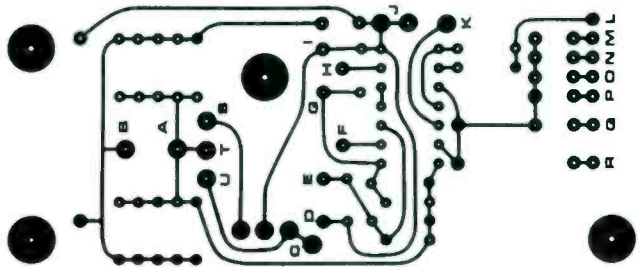


Fig. 2—Although none is really necessary here's a foil trace pattern for the Super Breadboard. The letters will help you connect the off-board components correctly.

The complete circuit uses one CD4584 hex schmitt trigger buffer amp. The package contains six buffers. Two are used for the pulse generator with another used as a buffer between the generator and the board. The other three sections are used for the positive and negative bounceless push-button circuits.

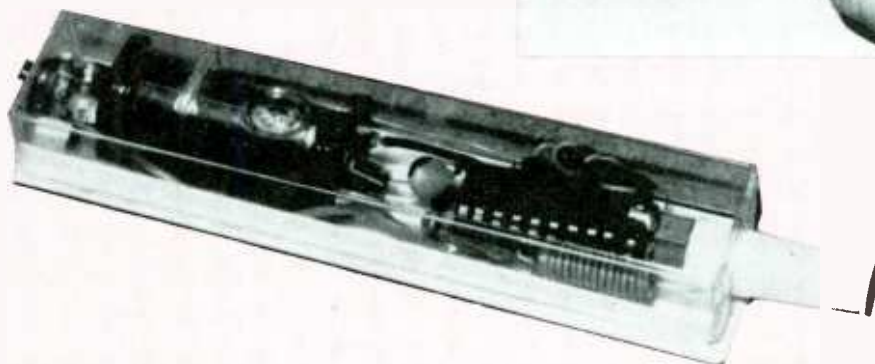
#### The Clock Circuit

The clock-pulse generator produces a square wave that is buffered from the generator by an extra buffer stage. That prevents loading of the generator by the circuit to which it is connected.

Due to tolerances in the capacitors used for range switching in the clock circuit, the clock generator is a little short on accuracy. It is well within the tolerances needed for supplying clock pulses in the right frequency range for circuit development. If accuracy is required, a common resistor can not be used and each switch position would require a different resistor in the place of R2. The general clock pulse ranges are 10-, 100-, 1000-, 10K-, 100K-, and 1 Mega-hertz.

(Continued on page 106)

# 7000 MINI FM RECEIVER



**Build a radio so small that it can fit into a gum package**

By Sam Allen

**M**uch of the fun in building electronic do-dads is derived from making something unusual—rarely seen or not readily available on the commercial market. Well, a single chip (the TDA7000) provides the opportunity to do just that. With just a handful of parts, you can build the *7000 Mini-FM Receiver*. The circuit is so small that it can be mounted in almost any enclosure imaginable; a pack of gum, for instance, as revealed by the photos.

There are none of the usual preparations to deal with. The circuit is built on a 20-pin low-profile IC socket (which serves as a chassis), using point-to-point wiring to complete the circuit (see photos).

Despite its small size and simplicity, the circuit provides good selectivity, sensitivity, and audio quality. In a metropolitan area, I've been able to pick up most local stations with a 6-inch antenna.

## Chip-Chat

Figure 1 shows a complete schematic diagram of the 7000 Mini FM Receiver. The integrated circuit (U1) is practically a complete FM receiver on a single silicon chip. The chip contains a local-oscillator and mixer, followed by a two-stage active IF filter. An IF limiter/amplifier feeds an FM demodulator, and an audio muting circuit is controlled by an IF waveform correlator. The few external parts required function primarily to determine the circuit's frequency range.

Most FM receivers use an IF frequency of 10.7 MHz—a range beyond that of active RC filters that can be easily integrated, thereby necessitating the use of coils in the tuned circuits.

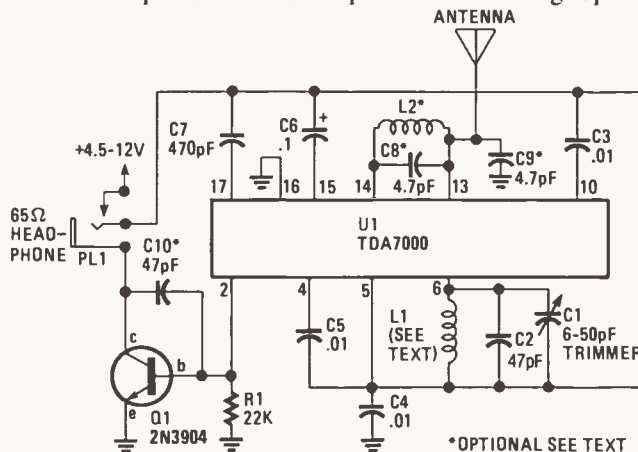
The TDA7000 gets around that problem by using an IF frequency of 70 kHz, a frequency that can be tuned by active RC filters (consisting of chip resistors and op-amps). An

external coil is still needed to tune the local-oscillator, but IF coils are completely eliminated. A coil can also be used in an RF bandpass filter in the antenna circuit to attenuate high-level AM signals.

## Construction

A 20-pin IC socket serves as the chassis for the radio. Since the socket has two more pins than the IC, the pin numbers won't correspond. In the directions, all pin numbers refer to the *socket's pin numbers*. The pin numbers shown on the schematic are the IC pin numbers.

The extra pins are used as tie points for the tuning capaci-



**Fig. 1—The integrated circuit (U1) is practically a complete FM receiver—containing a local-oscillator and mixer, a two-stage active IF filter and limiter/amplifier, FM demodulator, and an audio muting circuit—on a single silicon chip. The few external parts required function primarily to determine the circuit's frequency range.**



tor. Refer to the photos for the parts layout on the upper half of the socket. (Another photo details the underside.)

Begin construction by soldering the tuning capacitor (C1) to the socket. If you use the capacitor specified in the Parts List, it will have two large terminals that are connected to the rotor plates and one smaller terminal, which connects to the stator plates. Solder the two large terminals to pins 10 and 11 on the socket. That gives the capacitor a strong mechanical attachment to the socket.

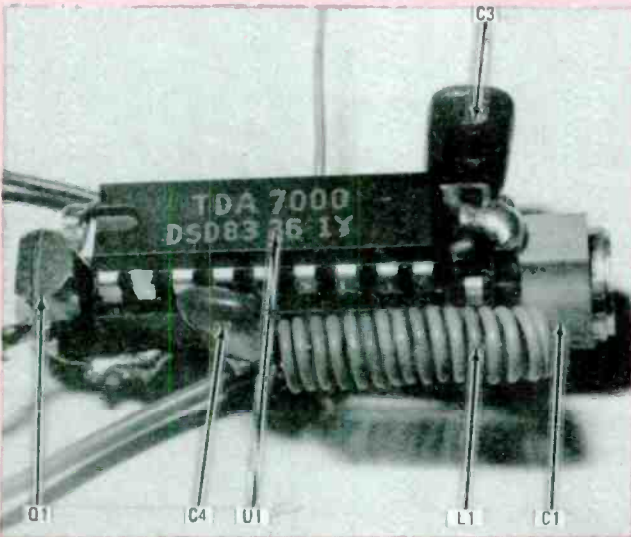
The stator plates are connected to pin 6 on the socket with a short jumper. That helps to eliminate hand-capacitance problems when tuning. If you connect the rotor plates to pin 6, touching the tuning shaft will detune the circuit. Place C2 between the socket and the back of the tuning capacitor. Solder one lead to pin 11 and the other to the small terminal

tween pin 4 and pin 5. Attach capacitor C6 between pin 5 and pin 17. Pin 5 will be getting a little crowded by now, so you can also make connections to the lead of C4 that is connected to pin 5.

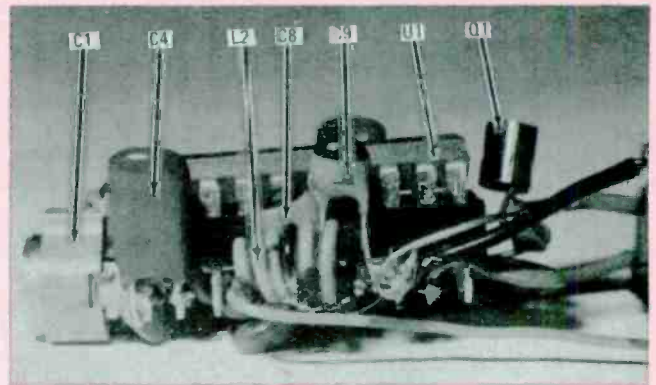
Connect the positive (+) lead of C6 to pin 5. Place C7 between the two rows of pins and connect one lead to pin 19 and the other to pin 5. Bend C7 down flat against the bottom of the socket.

Make coil L1 by winding 16 turns of 22-gauge insulated hookup wire on a 1/8-inch diameter form. I used the shaft of a small Phillips screwdriver as a form. Slide the coil off the form and connect it between pin 6 and pin 10.

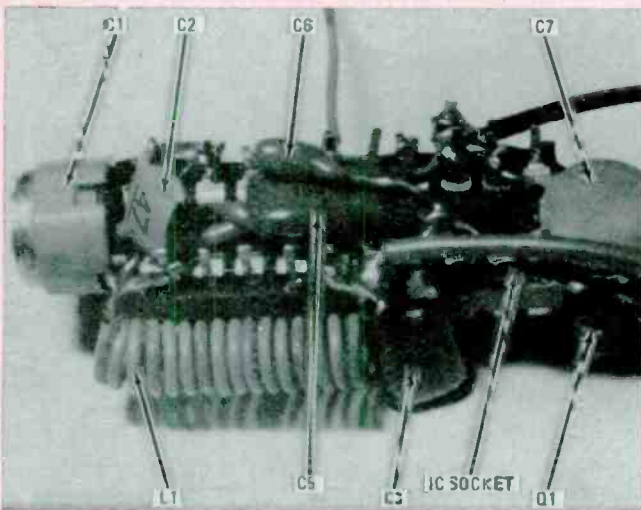
Resistor R1 is placed so that it extends across the front end of the socket. Solder one lead to pin 18 and the other to pin 2. Transistor Q1 is soldered to the leads of R1. Keep



This closeup of the radio shows the parts layout as viewed from the top of the socket.



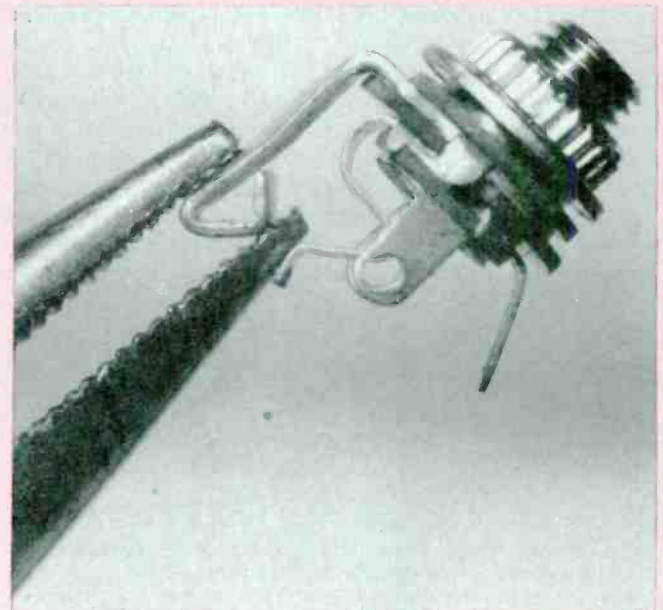
This view shows the optional parts needed to build the attenuator for use in areas of high signal strength.



To make the radio as compact as possible, parts are also placed on the underside of the socket.

on C1. Connect pin 10 and pin 5 with an insulated jumper. Attach one lead of C3 to pin 11 and the other to pin 12.

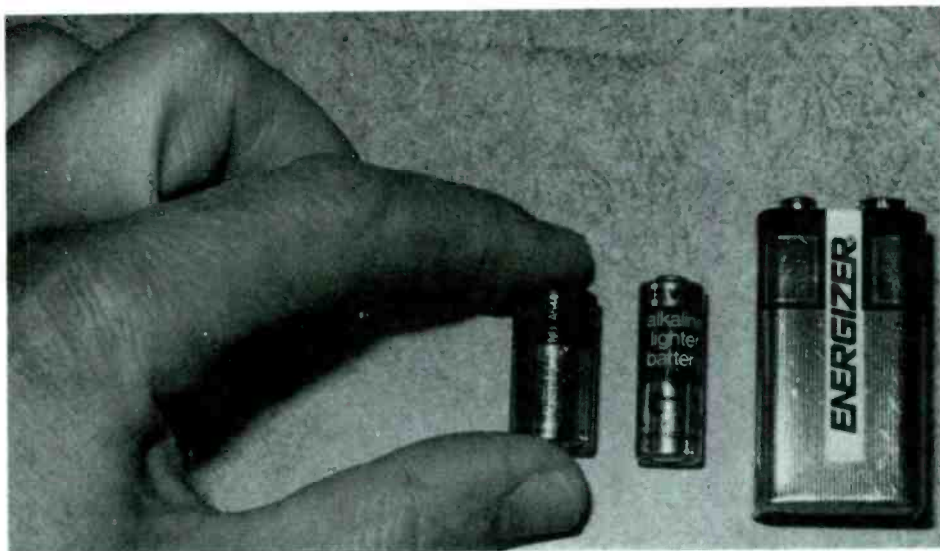
Connect C4 between pin 5 and pin 18. Position C4 flat against the bottom of the socket between the two rows of pins. Place C5 on the outside of the socket, connected be-



Bend the switch contact on the headphone jack to convert it from normally-closed to normally-open.

the leads short and clamp a heatsink or needlenose pliers to the leads as you solder to avoid any chance of thermal damage to the transistor. Connect the base to the lead on resistor R1 that's connected to pin 2 of the TDA 7000. Attach the emitter to the other side of resistor R1. Solder a piece of insulated wire to the collector lead of transistor Q1 and attach it to the headphone jack.





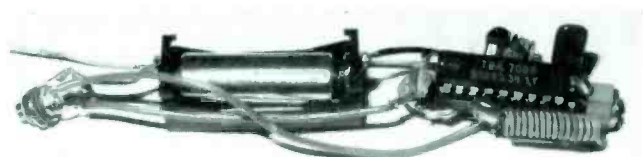
Here are three batteries that can be used with this radio. The smallest one on the left is a 6-volt battery; it will run the radio for about two hours of continuous use. The battery in the middle is a 12-volt battery that is cheaper than the 6-volt one, but it won't last as long. The 9-volt battery on the right is larger than the other two but will give you a lot more playing time for less money. Besides these batteries, you can use any combination of 1.5-volt cells that adds up to 4.5 volts to 12 volts.

Attach the positive (+) battery lead to pin 5. The negative (-) battery lead connects to pin 18. I used a 6-inch length of 22-gauge insulated wire (connected to pin 15) as the antenna. The radio is now ready for a test.

### Moment of Truth

Temporarily attach a 9-volt battery and a pair of Walkman-style headphones to the circuit. The headphones should have an impedance of about 65-ohms or greater—the amplifier won't drive an 8-ohm earphone. If you live in a strong-signal area, you should receive most stations with the short antenna. Small adjustments in the tuning range can be made by separating or compressing the coils of L1. If the sound is distorted, add the optional capacitor C10. I've found that some transistors needed that capacitor, while others worked fine without it.

I built the prototype while I was in a metropolitan area. It worked great while I was there. But, when I returned to my small hometown, the radio wouldn't operate—it was being swamped by the local AM station, located about a mile away. FM reception in our area is provided by translator stations that are fairly weak. To get the radio to operate under those conditions, I added an RF bandpass circuit (see photos). (Components for the RF-bandpass circuit are listed



An "N"-type battery holder will accommodate either the 6- or 12-volt battery specified in the Parts List. For long thin cases, put the battery holder end-to-end with the radio.

as optional parts on the schematic.)

Coil L2 is made in the same manner as L1—6 turns of 22-gauge insulated wire wound on an 1/8-inch core. Though a coil of that size provides a lot less inductance than called for in the data sheet, it keeps the coil small and it works. I also lengthened the antenna to about 12 inches to pull in the weak translator. Unless you are in a similar situation, you won't need to make those modifications.

You can experiment with both coils L1 and L2 to customize this circuit. You can make the coils smaller if you use

enameled wire. You can also change the frequency band covered by varying the number of turns. The basic circuit will cover frequencies from 1.5 MHz to 110 MHz; the only modification necessary is to change the coils and the capacitance of C1, C8, and C9.

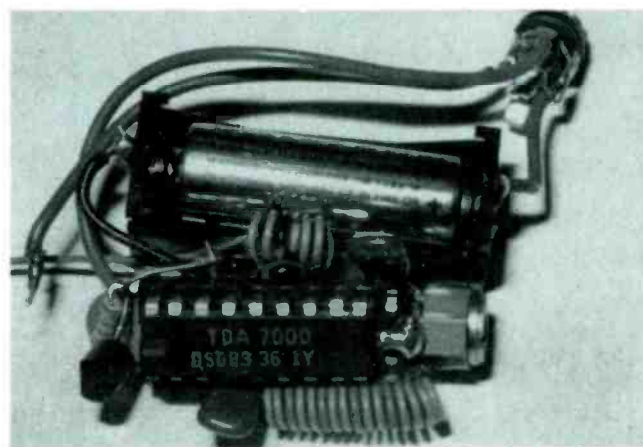
Once you have a working radio, you can add the headphone jack and battery holder in an arrangement that will fit the case you have in mind.

The headphone jack is modified to act as the on-off switch. Use an open-frame closed circuit type. Using needlenose pliers, bend the switch contact as shown in Fig. 7. Now instead of opening the circuit when the plug is inserted, it will close the circuit. If you use a mono jack, you'll hear only the audio in one earpiece, unless you use a mono-to-stereo adapter plug.

You can use a stereo jack and wire the two sides together. If you want an earpiece that is smaller than the standard headphone, get a pair of mini-headphones (the type without a headband). Split the cable into two separate pieces and connect a mono plug to each. Now you have a 65-ohm mono earpiece that is about the same size as a small 8-ohm earpiece.

### A Little Power Please

The radio can be powered from a DC source of 4.5 to 12 volts without modification, so you have a wide selection of batteries (see photos). The radio is so small that the battery will probably take up more room than the rest of the compo-



For a shorter but wider configuration, place the battery holder side by side with the radio.



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## 76 Hands-on Electronics FactCard Op-Amp Circuits

### SCRATCH FILTER

## 77 Hands-on Electronics FactCard 4030 Quad Exclusive-OR Gate

A	B	J
0	0	0
1	0	1
0	1	1
1	1	0

WHERE: "1" = HIGH LEVEL  
"0" = LOW LEVEL

**FEATURES**

- Wide supply voltage range
- Low power
- Medium speed operation
- High noise Immunity

**APPLICATIONS**

- Automotive
- Data terminals
- Instrumentation
- Medical electronics
- Industrial controls
- Remote metering
- Computers

**ABSOLUTE MAXIMUM RATINGS**

Voltage at Any Pin (Note 1)  $V_{DD} - 0.3V$  to  $V_{DD} + 15.5V$

Operating Temperature Range

CD4030M -55°C to +125°C

CD4030C -40°C to +85°C

Storage Temperature Range -65°C to +150°C

Package Dissipation 500 mW

Operating  $V_{DD}$  Range  $V_{SS} + 3.0V$  to  $V_{SS} + 15V$

Lead Temperature (Soldering, 10 seconds) 260°C

## 78 Hands-on Electronics FactCard LF442A Dual Low-Power JFET Op-Amp

**FEATURES**

- 1/10 supply current of a LM1458
- Low input bias current
- Low input offset voltage
- Low input offset voltage drift
- High gain bandwidth
- High slew rate
- Low noise voltage for low power
- Low input noise current
- High input impedance
- High gain  $V_O = \pm 10V, R_L = 10k$

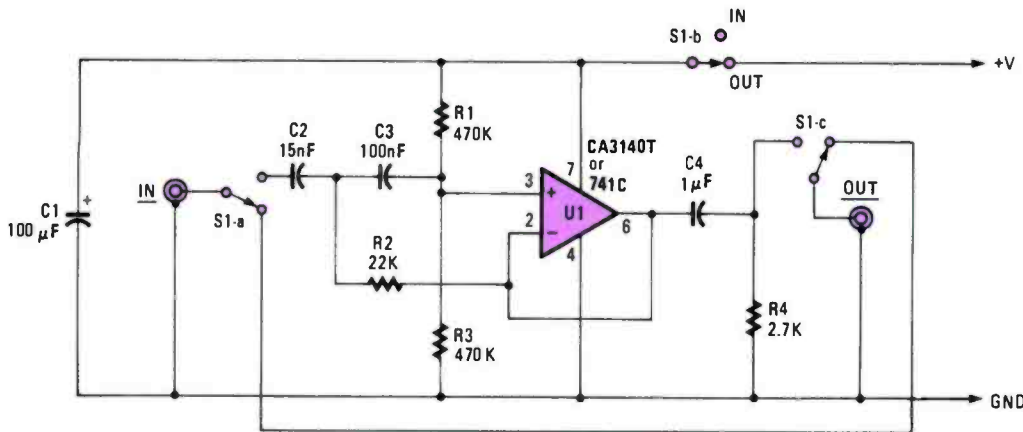
**ABSOLUTE MAXIMUM RATINGS**

	LF442A	LF442
Supply Voltage	$\pm 22V$	$\pm 18V$
Differential Input Voltage	$\pm 38V$	$\pm 30V$
Input Voltage Range	$\pm 19V$	$\pm 15V$
Output Short Circuit Duration	Continuous	Continuous
Power Dissipation $\theta_{JA}$	670 mW	500 mW
$T_{max}$	150°C	115°C
	150°C/W	160°C/W

# 76 Hands-on Electronics FactCard

# Op-Amp Circuits

RUMBLE FILTER



# 77 Hands-on Electronics FactCard

# 4030 Quad Exclusive OR Gate

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS at 25°C (Typ.)	UNITS
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)		
Quiescent Device Current, I <sub>DD</sub> Max.	—	0.5	5	0.02	µA
	—	0.10	10	0.02	
	—	0.15	15	0.02	
	—	0.20	20	0.04	
Output Low (Sink) Current I <sub>OH</sub> Min.	0.4	0.5	5	1	mA
	0.5	0.10	10	2.6	
	1.5	0.15	15	6.8	
Output High (Source) Current, I <sub>OH</sub> Min.	4.6	0.5	5	-1	mA
	2.5	0.5	5	-3.2	
	9.5	0.10	10	-2.6	
	13.5	0.15	15	-6.8	
Input Current I <sub>IN</sub> Max.	—	0.18	18	±10 <sup>-5</sup>	µA

CHARACTERISTIC	CONDITIONS			LIMITS at 25°C (Typ.)	UNITS
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)		
Output Voltage: Low-Level, V <sub>OL</sub> Max.	—	0.5	5	0	V
	—	0.10	10	0	
	—	0.15	15	0	
Output Voltage: High-Level, V <sub>OH</sub> Min.	—	0.5	5	5	V
	—	0.10	10	10	
	—	0.15	15	15	
Input Low Voltage, V <sub>IL</sub> Max.	0.5, 4.5	—	5	—	V
	1.9	—	10	—	
	1.5, 13.5	—	15	—	
Input High Voltage, V <sub>IH</sub> Min.	0.5, 4.5	—	5	—	V
	1.9	—	10	—	
	1.5, 13.5	—	15	—	

# 78 Hands-on Electronics FactCard

# LF442A: Dual Low-Power JFET Op-Amp

DC ELECTRICAL CHARACTERISTICS

Characteristic	Conditions	LF442A Typ	LF442 Typ	Units
Input Offset Voltage V <sub>OS</sub>	R <sub>S</sub> = 10 kΩ T <sub>A</sub> = 25°C	0.5	1.0	mV
	Over Temperature			mV
Average TC of Input Offset Voltage ΔV <sub>OS</sub> /ΔT	R <sub>S</sub> = 10kΩ	7	7	µV/°C
Input Offset Current I <sub>OS</sub>	V <sub>S</sub> = ±15V T <sub>J</sub> = 25°C	5	5	pA
	T <sub>J</sub> = 70°C			nA
	T <sub>J</sub> = 125°C			nA
Input Bias Current I <sub>B</sub>	V <sub>S</sub> = ±15V T <sub>J</sub> = 25°C	10	10	pA
	T <sub>J</sub> = 70°C			nA
	T <sub>J</sub> = 125°C			nA
Input Resistance	T <sub>J</sub> = 25°C	10 <sup>12</sup>	10 <sup>12</sup>	Ω

Characteristic	Conditions	LF442A Typ	LF442 Typ	Units
Large Signal Voltage Gain A <sub>VOL</sub>	V <sub>S</sub> = ±15V, V <sub>O</sub> = ±10V, R <sub>L</sub> = 10 kΩ, T <sub>A</sub> = 25°C	200	200	V/mV
	Over Temperature	200	200	V/mV
Output Voltage Swing	V <sub>S</sub> = ±15V, R <sub>L</sub> = 10 kΩ	±13	±13	V
Input Common-Mode Voltage Range		+18	14	V
		-17	-12	V
CMRR	R <sub>S</sub> ≤ 10 kΩ	100	95	dB
Supply Voltage Rejection Ratio		100	90	dB
Supply Current		300	400	µA

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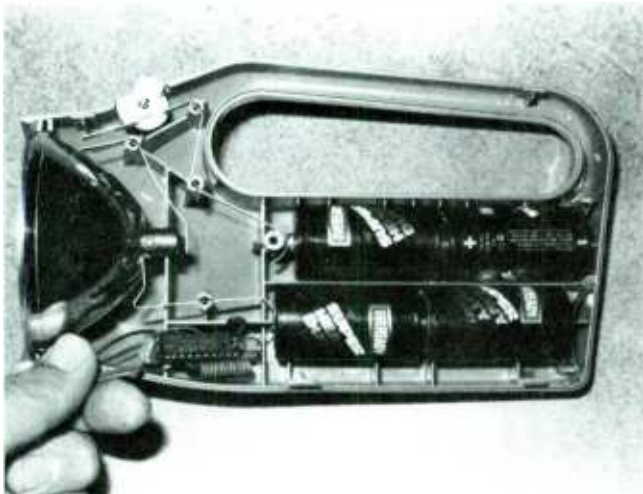


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The radio is small enough to fit into an unused nook in an existing piece of equipment; here it is being put into a flashlight. The four C-cells provide 6 volts to run the radio as well as the flashlight.

nents. For an ultra small radio, you will want to use the smallest battery possible; but the price you pay for small size is short battery life.

The Parts List gives two small batteries. The 6-volt battery should last about two hours under continuous use. The 12-volt unit doesn't last as long, but it costs less. Both batteries fit an "N"-type battery holder. If you can make the radio case a little larger, you'll get a lot more playing time for less money with a standard 9-volt battery.

The battery arrangement depends on the type of case you intend to use. If the case is large enough for a 9-volt unit, then just add a battery snap. For a really compact radio, use the "N"-type battery holder. If you intend to put the radio in something like a marking pen, then place the battery holder end to end with the circuit (see photos).

For other applications, you can mount the battery holder alongside the circuit (Fig. 10). You may come up with a case that eliminates the need for a battery holder; for example, if you mounted the radio in a penlight case, you could use the battery holder that is in the penlight. You can fit 3 "N" cells and the radio into some of the larger penlights. Since the circuit will work on any voltage between 4.5 V



The radio is small enough to fit into a gum wrapper.

## PARTS LIST FOR THE 7000 RADIO

### SEMICONDUCTORS

- Q1—2N3904 NPN general-purpose silicon transistor
- U1—TDA 7000 (Radio Shack #276-1304) FM receiver, integrated circuit

### CAPACITORS

- C1—6-50-pF trimmer
- C2—47-pF ceramic disc
- C3-C5—.01- $\mu$ F ceramic disc
- C6—.1- $\mu$ F Tantalum
- C7—470-pF ceramic disc
- C8, C9—4.7-pF ceramic disc (optional see text)
- C10—47-pF ceramic disc (optional see text)

### ADDITIONAL PARTS AND MATERIALS

- L1—16-turns, 1/8" inside diameter, 22 gauge insulated wire. L2—6-turns, 1/8" inside diameter, 22 gauge insulated wire (optional see text)
- R1—22,000-ohm, 1/4-watt, 5% resistor
- Low-profile IC socket (20 pin), "N"-type battery holder or 9-volt battery connector, headphone jack (open-frame, closed-circuit), headphone (65-ohm Walkman type) hook-up wire, solder, hardware etc.

### SUGGESTED BATTERIES

- Standard 9-volt battery
- Eveready A544, 6-volt battery
- Radio Shack #23-144, 12-volt battery

and 12 V, you can mount it in something that already contains batteries and tap power for the radio; for example, you could mount it inside a flashlight that has three or more cells (Fig. 11).

### Room, No Board

You can really let your imagination run wild when it comes to the case for this radio. It fits inside practically anything. The photos show a few examples. The gum and candy packages are fun adult novelties, but come with one caution. If you do disguise the radio as candy, keep it away from very small children that may try to eat it!

The keychain radio is actually one of the most practical for day-to-day use even if it isn't as unusual as some of the others. The case is a leather luggage tag. You can mount the radio in a stuffed animal after a little surgery. Cut open one of the seams and remove some of the stuffing. Add a zipper or some Velcro so you can easily change the battery.

If you have a favorite station that you listen to all the time, you can tune it in with an alignment tool and leave the tuning capacitor alone after that; but you will probably want to add a tuning knob. You can glue practically any small plastic knob to the tuning capacitor using Super glue. I used the cap to a felt tip marker for a knob. (See photos.) It is a perfect friction fit over the tuning shaft. The lid from a tube of toothpaste or something similar could also be used.

If you want to show off the radio, rather than disguise it, a clear plastic toothbrush case is ideal. The adult size is much bigger than needed, so use the case from a child's toothbrush. I attached the radio to the base of the case with hot-melt glue and made holes for the tuning knob and the headphone jack.

No matter how you package it, you'll have fun making and using this compact radio. ■

# THE MAGNETISM LAB

**Philosophers and scientists were mystified for centuries over the nature of magnetism. You can fiddle with that amazing force at home, but, unlike them, you'll know what you're doing**

By Stan Czarnik

**T**HE NATURALLY OCCURRING MAGNETIC MINERAL called magnetite, or lodestone, will pick up and hold small bits of iron. The unique attractive power of lodestone has been known for a very-long time.

Nearly two thousand years ago, the Roman poet and philosopher Lucretius believed that the surface of lodestone was covered with tiny hooks which joined with tiny ringlets on the surface of iron. That was why the iron and the lodestone stuck together. During the Middle Ages, magnetic attraction was explained by a kind of "living spirit" within the iron that "obeys" the lodestone. The power of the lodestone could be destroyed with garlic juice. The power could be restored by immersing the stone for three days in the blood of a goat.

Exactly when lodestones, or iron needles rubbed with lodestones, were first used to determine direction and aid navigation is not known. One early reference dates to the latter part of the twelfth century. It is in a work written by Alexander Neckham, a European monk, and he does not regard the directive property of the magnet as something new.

## The Origin of Lodestones

The power of natural magnets to orient themselves in space is what gives the lodestone its name. The original meaning of "lodestone" is "leading-stone." The derivation of the term "magnet" is very different. That word traces back to the Greek Magnes, short for Magnes lithos, "the Magnesian stone." Magnesia is a metalliferous section of Thessaly on the Aegean coast where lodestones were found.

Lodestones are often available at rock shops and gem shows. They are not expensive. Drag a lodestone through a pile of small iron or steel objects and it will pick them up. You will find that most lodestones are not very strong. A primitive compass can be made by suspending a lodestone from a thread or thin string. The lodestone will orient itself in a north-south direction. Make sure the stone is balanced and can turn freely (Photo 1). If possible, use a stone with a roughly rectangular shape.

## History of Experimentation

The first extended investigation of magnetism, entitled *Epistle on the Magnet*, was written in 1269 by Pierre de Moiricourt, otherwise known as Peter Peregrinus. Peregrinus was an engineer in the war camp of Charles of Anjou during a siege of the city of Lucera in South Italy. His job was to design machines for hurling stones at enemy fortifications.



Photo 1

Nature's magnet, the lodestone was (and is) quite an interesting object to possess. It is one of nature's permanent magnets used even in ancient China by the Mongols.

The siege was a long one, and Peregrinus filled his time with magnetic experimentation.

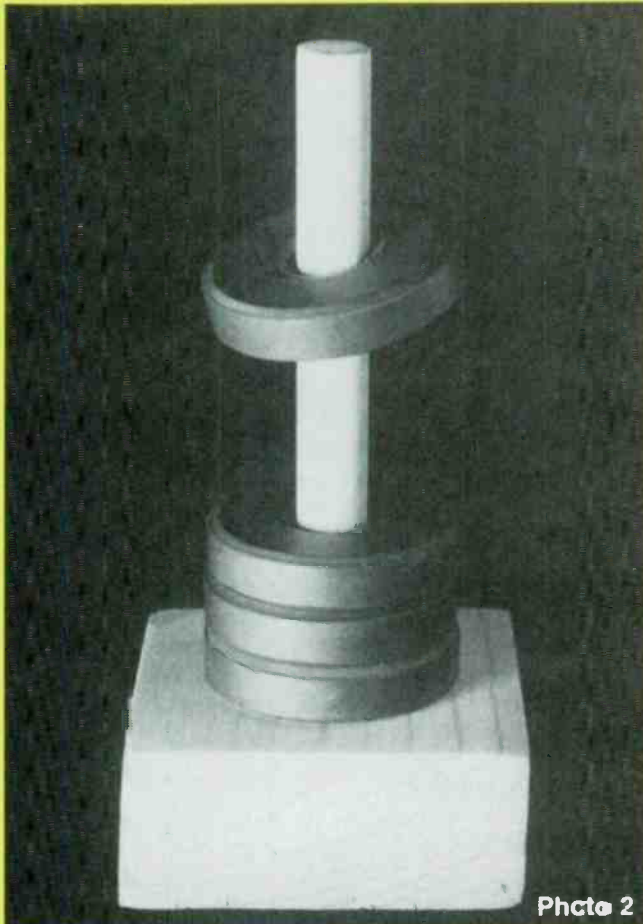
Peregrinus saw that the way in which magnets maneuver themselves, attract each other, or repel each other, depends entirely on the position of their poles. It is in his *Epistle* (a long letter, actually) to a friend back in France, that Peregrinus introduces the notion of polarity, an idea central to so much natural philosophy in the centuries ahead.

The observations of peregrinus were later elaborated by William Gilbert (1540-1603), John Mitchell (1724-1793), and others.



The effects of magnetic polarity can be illustrated by means of a simple levitation device built from a few scraps of wood and some ring magnets from Radio Shack. Cut a small square of wood from a piece of lumber. The piece in the photograph is 1½ by 1½ inches and about ¾ inch thick. Drill a hole in the center just large enough to accommodate a 5/16 inch dowel. The rod should be between 3½ and 4 inches long. Push the rod into the hole in the block and secure it with a few drops of glue if necessary.

Now obtain four or five ring magnets and stick all but one together at the bottom of the rod. Place the remaining magnet on the rod so that the polarity of its lower face matches that of the upper face of the top magnet on the pile. Since unlike poles attract, the lower magnets adhere to each other. Since like poles repel, the final magnet will float over the others. Push it down, and it will spring back up (Photo 2).



Like magnetic poles don't like each other. The repulsion of like poles is strong enough to suspend a magnet from which it emanates. The bottom ones are positioned for attraction.

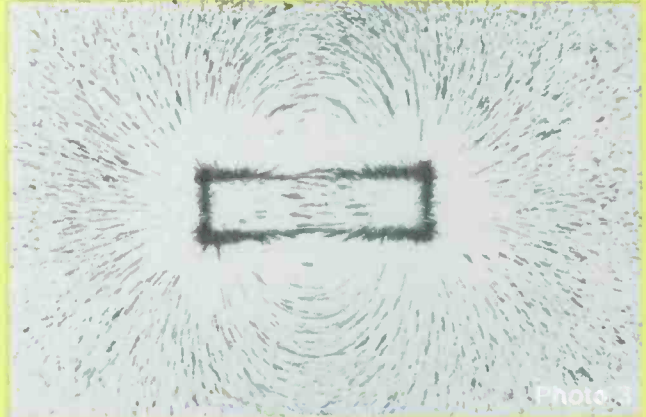
### Magnetic-Force Lines

Peter Peregrinus was also one of the first to use bits of iron to reveal what we now call, following Michael Faraday (see below), magnetic lines of force. Anyone who has ever leafed through a book of elementary physical principles is familiar with those interesting magnetic designs.

It's easy to do. Obtain a small bar magnet and place it on a table between two pieces of wood or plastic. The wooden pieces should be about as thick as the magnet. Cover the magnet and the wood with a sheet of paper. Sprinkle some iron filings on the paper; an old salt shaker is very good for

this. The wood supports the paper and prevents the filings from sliding off. Tap the paper gently and the iron will align itself within the force field of the magnet.

Note how the lines of force curve out and then return to connect the opposite poles of the magnet. No two lines of force cross. Note also how the lines of force crowd together at the ends of the bar (Photo 3).



Iron filings sprinkled from salt shaker reveal magnetic lines of force. The magnetic field only appears as lines in the presence of the iron filings which concentrate the field. The field surrounds the whole space around the magnet.

A warning. Be very careful with the iron filings. They are flammable and will burn with a small spark-like flash if thrown into an open flame.

### Electricity and Magnetism

Philosophers of the eighteenth century wondered whether some sort of relationship might exist between magnetism and electricity. This suspicion was fed, in part, by certain strange effects produced by lightning. The following was reported in the *Philosophical Transactions* in 1735.

A tradesman in the English town of Wakefield placed some knives and forks in a box. He placed the box in the corner of a large room. Later, during a sudden thunderstorm, that corner of the room was struck by lightning. The room was damaged, the box was split, and some of the knives and forks melted. The tradesman emptied the box on a counter. There were some nails on the counter. The nails stuck to the melted forks. The utensils had become magnetized.

Despite some determined experimentation, the connection between electricity and magnetism remained out of reach. In 1805, for example, two French investigators suspended a voltaic battery in an effort to determine whether it would function like a compass and point north. That did not work.

### Oersted's Experiment

The breakthrough came, as breakthroughs often do, to a mind prepared to recognize the significance of the unexpected. Hans Christian Oersted (1777–1851), professor of Natural Philosophy at Copenhagen, believed that all natural forces are expressions of one, unitary "primordial" force. That position points to the metaphysical influence of the German philosopher Immanuel Kant. That was the conviction that sustained Oersted in his long search for the magnetic effect of electricity.

Oersted also knew how compass needles were sometimes set into motion during thunderstorms. He thought he might be able to duplicate that motion with a current-carrying wire.

It is the winter of 1819–20. First, he placed the wire at right angles to the compass needle. Nothing happened. Then, he was struck with another idea. He thought of placing the wire parallel to the needle. The needle moved. He repeated the experiment with more powerful apparatus, and, once again, it worked. Magnetism had been produced from electricity.

### Oersted Made Easy

You can recreate Oersted's demonstration in your home laboratory. Obtain a toy compass. Run a current through a length of insulated wire with a battery. Stretch the wire directly over and parallel to the compass needle. The needle will be deflected. If there is enough current in the wire, the needle will form a right angle with the wire (Photo 4). Reverse polarity at the battery, and the needle will swing around in the opposite direction.

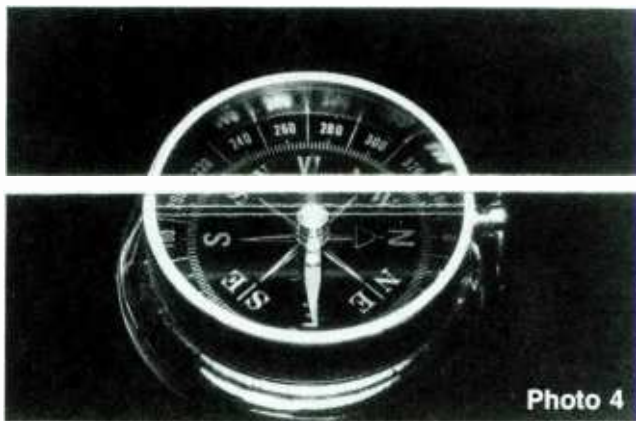


Photo 4

In Oersted's demonstration a compass needle responds to the magnetic field surrounding current-carrying wire.

One more warning: **Do not** use an electronic power supply for this or any other experiment described in this article; it could be damaged and may not deliver enough current in any case. Use a battery. An Eveready 1.5 volt Ignitor Dry Cell, or equivalent, is a good choice. Do not leave the battery connected for more than one or two minutes.

### Oersted Revisited

A more elaborate version of Oersted's experiment requires two compasses, a couple of empty jars, and a metal rod. Support the metal rod in a vertical position. A block of wood with a small hole in the center makes a satisfactory stand. Place two inverted glass jars next to the metal rod, one on each side. Place the compasses on top of the jars. Now run wires from the lower and upper section of the rod to a battery (Photo 5). The purpose of the jars is to keep all conductors, with the exception of the vertical conductor, as far away as possible from the compass needles.

With electricity from the battery running through the vertical metal rod, the compass needles will be deflected. Note that they point in opposite directions (Photo 6). That shows that the magnetic lines of force take the form of a circle around the vertical conductor.

The direction of magnetic lines of force is usually understood as being north-to-south. That means that the lines of force in Photo 6 are moving in a clockwise direction. That is because the lower section of the rod is connected to the negative terminal of the battery and the upper section is connected to the positive terminal. If the polarity at the

Photo 5



A compass can be used to determine magnetic lines of force around a vertical conductor such as a rod. Alligator clips are used to attach wires to the rod.

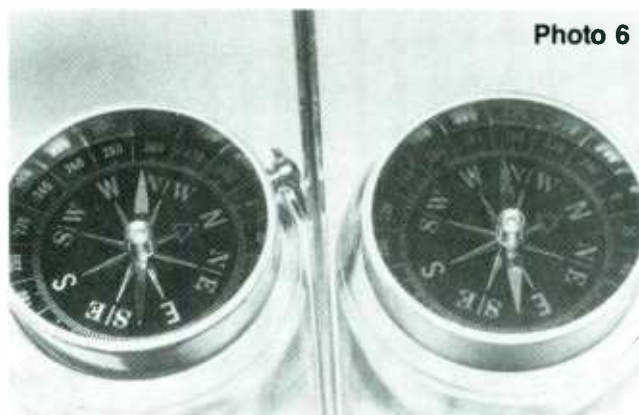


Photo 6

Compass needles point in opposite directions. This shows that the magnetic lines of force around the current-carrying metal rod take the form of a circle.

battery is reversed, the direction of the lines of force will also be reversed.

So, in other words, the direction of current through the conductor determines the direction of the lines of magnetic force around the conductor. That is an illustration of what is sometimes called Fleming Rule.

### The Electromagnet

Following Oersted's discovery, things moved along quickly. One week after news of the Oersted effect reached him, Andre-Marie Ampere (1775-1836), showed how wires can be made to attract or repel each other by changing the direction of the current flowing through them. Ampere also predicted that the strength of the magnetic force around a wire could be increased by coiling the wire. In such a coil, or solenoid, the lines of force around each loop of wire reinforce those of its neighbor. The result is a force field resembling that found around a bar magnet. To the branch of electrical science which deals with the mutual action of currents Ampere gave the name *electrodynamics*.

At about the same time, another Frenchman, Dominique Fancois Arago (1786-1853), found that an ordinary iron needle placed inside a current-carrying coil of wire will become magnetized.

William Sturgeon (1783-1850), a man well-known for his interest in electrical experimentation, was inspired by Arago's results. In 1823, sturgeon took a bar of soft iron one foot long and one-half inch in diameter, bent it into the shape of a



horseshoe, and wrapped it around with sixteen turns of copper wire. It was the first true electromagnet. Powered by current from a single voltaic battery, Sturgeon's creation could lift nine pounds.

With a large nail of iron or steel and some magnet wire, you can build an electromagnet similar to the one constructed by Sturgeon.

### Building an Electromagnet

Making coils of any kind is always a time-consuming business. To make the job a little easier, place a large nail in a small vise before you start winding (Photo 7). Wind the magnet slowly and keep the turns as tight and as even as possible. A single layer of wire on the nail is enough to generate the electromagnetic effect. The electromagnet in the photograph was wound with 22 gauge wire, the heaviest gauge in the package.

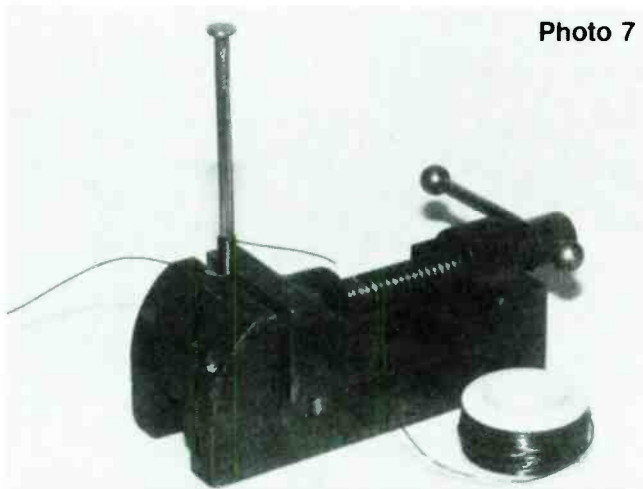


Photo 7

Place the coil form, a large nail in this case, in a small vise before winding the electromagnet. Clamping the pointed end will of course be easier than clamping the head.

Connect the magnet to your dry cell. You will find that it will lift a large number of pins or small nails. Note how much stronger this very simple artificial magnet is than the lodestone (Photo 8). The strength of an electromagnet is determined mainly by two factors: the number of turns in the coil and the amount of current passing through it.

When you disconnect the battery, most of the pins will fall away. A few pieces, however, will remain stuck to the core. That is due to a small amount of magnetism left in the core. It is called residual magnetism.

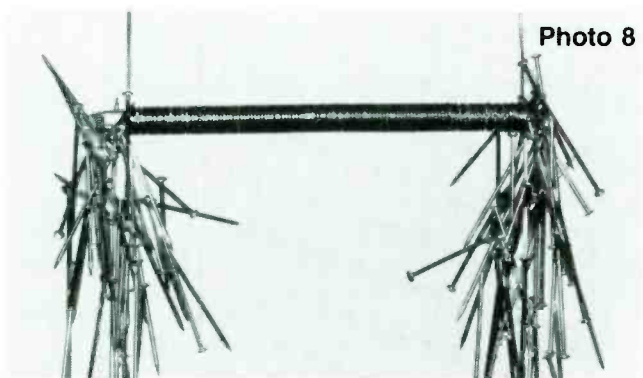


Photo 8

This simple electromagnet, connected to a 1.5-volt dry cell, will lift a large number of steel pins. With a better coil and enough current, you could lift a car.

### PARTS LIST FOR THE MAGNETISM LAB

Bar magnet  
Dowel Rod, 5/16-in. diameter  
Dry cell, 1.5-volt (Eveready IS6 or equivalent)  
Glass jars (2)  
Hook-up wire (for 2 coils)  
Iron or steel bar  
Iron filings, 1 oz.  
Large nail  
Lodestone (see text)  
Magnet wire  
Metal rod  
Push-button or momentary-contact switch  
Ring magnets (3 or 4)  
Salt shaker (see text)  
Toy compasses (2)  
Voltmeter  
Wood blocks (see text)

### ADDITIONAL PARTS AND MATERIAL

White paper, string, wire, hardware, a small vise, and some light iron or steel objects like staples, pins, or small nails.

Good bar magnets are often available from a science surplus house called Jerry Co, 601 Linden Place, Evanston, IL 60202 (catalog \$.50).

Iron filings can be ordered from any laboratory supply company. One such place is Hagenow Laboratories, 1302 Washington, Manitowoc, WI 54220 (catalog \$1.00).

### Permiability

Some materials permit magnetic lines of force to pass through them more easily than others. Iron is one of these materials. Any material that permits the magnetic flux to pass with little or no resistance is said to have a high degree of permeability. The reverse of permeability is reluctance. Compared to iron, air has low permeability and high reluctance. Compared to air, iron has high permeability and low reluctance. Magnetic lines of force always take the path of least opposition. Thus, the iron core of your electromagnet functions to gather and concentrate the magnetic lines of force.

The strength of the electromagnetic field will increase as the current passing through the wire coil surrounding the core is increased. However, there comes a point at which the core material cannot contain additional lines of force. When that happens, the core is said to be saturated.

### Faraday's Coils

Michael Faraday was born in London on September 22, 1791; he was the son of a Yorkshire blacksmith. His family was poor and his education rudimentary. In 1804, at the age of thirteen, Michael Faraday took his first job, as a bookseller's errand-boy. After a year of delivery, he was promoted to apprentice bookbinder. A close contact with more books than he had time to read, gave way to an interest in science, especially electrical science and chemistry. He spent what little money he had on making apparatus and repeating the experiments about which he learned. From those simple beginnings Michael Faraday went on to become one of the most brilliant experimental scientists of all time.

Early in 1813, the Royal Institution decided to hire a new laboratory assistant. Faraday, who had been attending lectures at the Institution, was offered a job. Faraday worked

with Sir Humphrey Davy, another gifted and versatile scientist, whose greatest discovery, it is sometimes said, was Faraday.

### Faradays Work

Under the influence of Davy, Faraday's early work was in chemistry. Following Oersted's demonstration, his attention turned to electromagnetism. He hoped to formulate analogies between the action of static electricity and the action of the continuous currents available from voltaic batteries. It was known that static charges could "induce" an opposite electrified condition on nearby materials. So Faraday speculated: Might not voltaic currents possess a similar power?

At first, the idea was to get a current flowing in one circuit (the primary) and permit it to induce a current in a neighboring circuit (the secondary). The induced current in the secondary was supposed to persist as long as the inducing current persisted in the primary. But this is not quite what happened.

Induced currents did indeed appear in the secondary circuit, but only when the primary current was started or stopped. The primary current alone was not enough. Secondary currents would be induced only when the primary current was interrupted. Faraday found that electromagnetic induction is possible only when magnetic fields move. That is the essence of Faraday's discovery.

### Induction

Faraday's crucial electromagnetic experiments are not hard to reproduce. In addition to the dry cell, obtain two coils of ordinary hook-up wire, a push button or momentary switch, an iron bar, and a voltmeter. Connect one coil of wire to the battery and the push button. Connect the other coil to the voltmeter. Place the coils on a table about 2 or 3 inches apart with the iron bar inserted between them as shown in the photograph (Photo 9). That is very similar to Faraday's original set-up, except instead of an iron bar, he used an iron ring. If your coils begin to unravel, try tying the wire together with some string.



Shown here is the apparatus for recreating Michael Faraday's discovery of electromagnetic induction. A couple of banana plugs are used to connect the coil to the voltmeter.

You're now ready. With your eyes on the voltmeter, activate the primary circuit by pressing the button. Hold the button down. A small voltage will be generated in the secondary circuit and register on the voltmeter. Very quickly, the reading will settle down to zero. Now, release the button. Another voltage of the opposite sign will appear on the voltmeter.

If the experiment fails to work to your satisfaction, there are a number of things you can do. You can try moving the coils closer together, try using a stronger battery, or, try

winding both the primary and the secondary directly onto the iron bar.

### Tackling the Concept

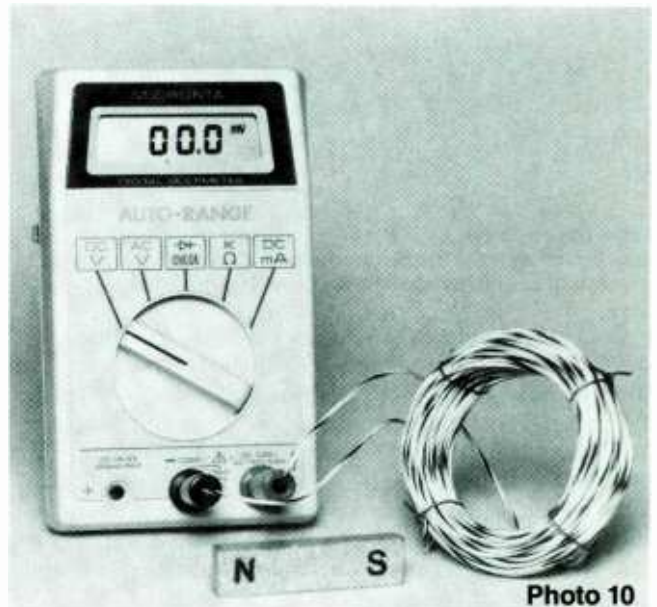
Faraday was perhaps the first to think consistently in terms of magnetic lines of force. That concept is central to an understanding of how induction operates.

When you close the primary circuit, a magnetic field develops. As the lines of magnetic force move across the secondary coil, electricity is generated. As soon as the lines of force stop moving, the generation of electricity also stops. When the button is released and primary circuit reopened, the magnetic field is again set into motion, only this time in the opposite direction. As the lines of force collapse into the coil, a current is again created, but of the opposite sign.

That was Faraday's great experiment; the date was August 29, 1831. Oersted produced magnetism from electricity. Faraday produced the reverse effect, electricity from magnetism. That also, of course, marks the origin of the transformer.

### Generating Electricity

On October 17 of the same year, Faraday succeeded in getting electricity directly from the action of an ordinary permanent magnet. The experiment was even simpler. You will need what Faraday needed: a voltmeter, a coil of wire, and a magnet (Photo 10). A fairly strong bar magnet works best.

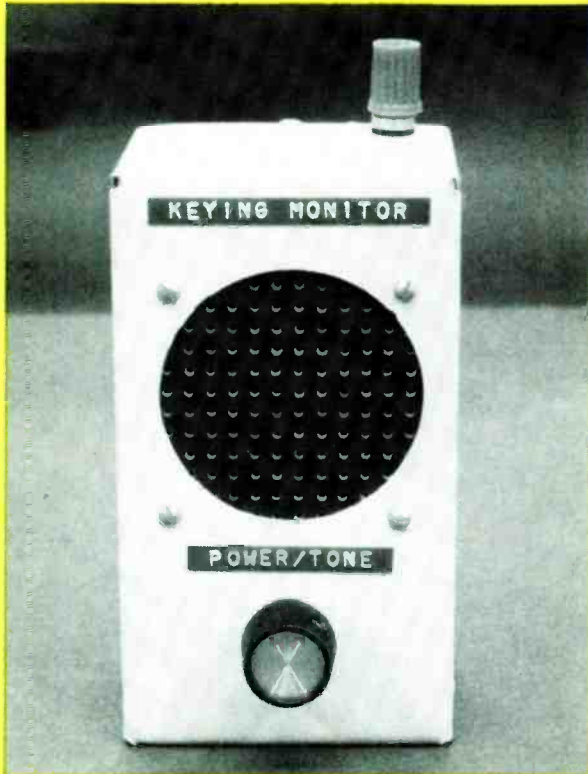


Push the magnet through the coil and, behold, electricity. Reversing the direction, reverses the current direction.

Connect the coil to the meter. Push one end of the magnet through the coil. A small voltage will register on the voltmeter. Now, withdraw the magnet. That will generate another voltage. Note: if you push the magnet all the way through the coil, you will get a double reading on the voltmeter.

Once again, a magnetic field in motion accounts for how the system works. As the magnet moves forward through the coil, the magnetic lines of force move with it. As they cut across the wire, electricity is generated. When the magnet stops, so does the current. As the magnet is pulled back to its original position, the magnetic lines of force again move across the coil, but from the other direction. That generates a voltage with the opposite sign. ■





# OFF-AIR KEYING MONITOR

**This keying monitor tells you what your morse signals really sound like to other hams so you can shape up your CW communications.**

By Herb Friedman

**E**VEN BEFORE THE ERA OF SOLID-STATE DEVICES, CW communications was considered an archaic means of communication that should have been put out to pasture *umpteenth* years ago. Yet even today the VHF Ham bands still boil with CW activity. And for a good reason. When radiotelephone signals are buried under 15 layers of QRM and QRN, or the signal is so weak the S-meter won't budge off its pin, even a pipsqueak (QRP) CW signal can still be heard and "work the world."

Yet for all its effectiveness, we can still hear seemingly endless radio amateurs with strong CW signals vainly calling CW and getting no response. Soon, yet another Ham loses interest in CW. The reason, of course, is not that no one is hearing the CW signal, but rather that the operator has a sloppy "fist," and other operators know that a contact will be long, s-l-o-w, and agonizing.

## The Main Problem

Generally, a sloppy fist is the result of the operator not monitoring the actual on-air signal. Usually, most of the effort that goes into learning the Morse Code—what we call CW—is spent learning to receive rather than to send. In fact, many operators judge their sending—particularly when on-the-air—by the clicks of the key, rather than by a tone monitor; and as we all learn the hard way, key clicks always sound good, even if the actual on-air "fist" really sounds like signals from another world.

But all it takes to hear how your fist actually sounds to others is the easy-to-build, off-the-air, keying monitor shown in the photographs. While I hate to use the trite cliché that the keying monitor is a junk-box project, this one actually was designed to use parts you probably have lying around from your early experiments with transistor circuits; parts you probably wouldn't dream of using in a modern circuit: such as the dreaded high-leakage germanium transistor and germanium small-signal diode.

## How It Works

As shown in Fig. 1, the keying monitor has two almost-separate sections: a phase-shift oscillator (based on Q3 and Q4), and an RF detector/DC-amplifier (containing D1, Q1, and Q2). Notice that battery B1's negative return to ground is through the Q1/Q2 amplifier.

The tone frequency of the Q3/Q4 oscillator is determined by the combination of R2/R3 and R4/C2. With the R4/C2 values shown, adjusting tone control R2 will vary the output tone over the middle-frequency range: those frequencies to which the ear is most sensitive.

Notice, however, that the oscillator cannot start until B1's negative terminal is connected to ground, and that is not done through POWER/TONE control S1. Battery B1 is grounded through transistor Q2, which is normally cut off.

When RF is applied to binding post BP1—either through a small antenna or a wire wrapped around the transmitter's transmission line—the small amount of sampled RF is rectified by diode D1, filtered (smoothed) to DC by capacitor C1,

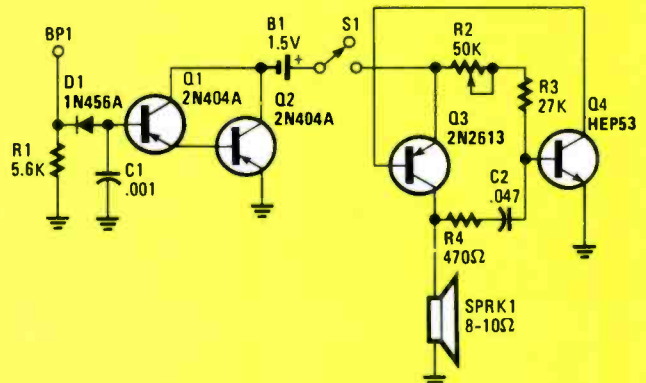
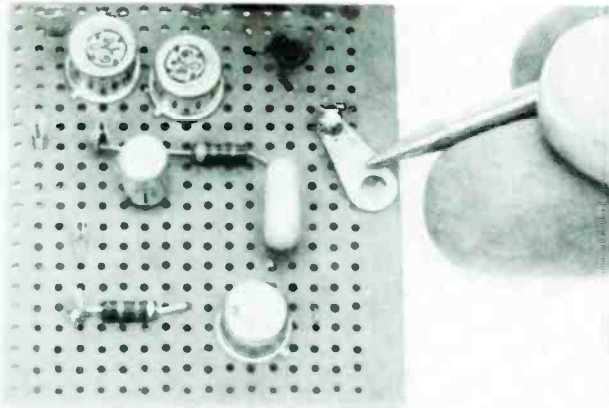
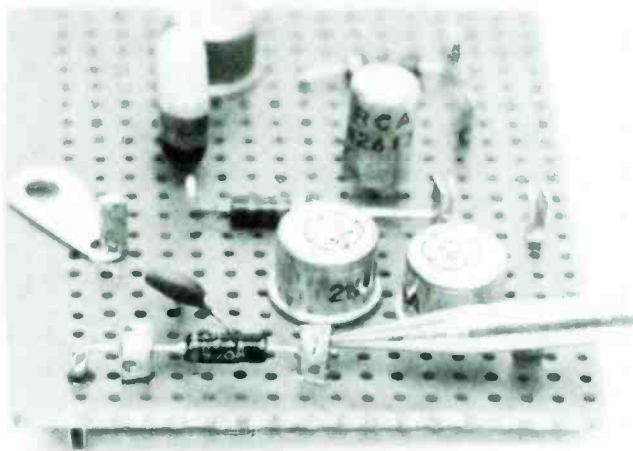


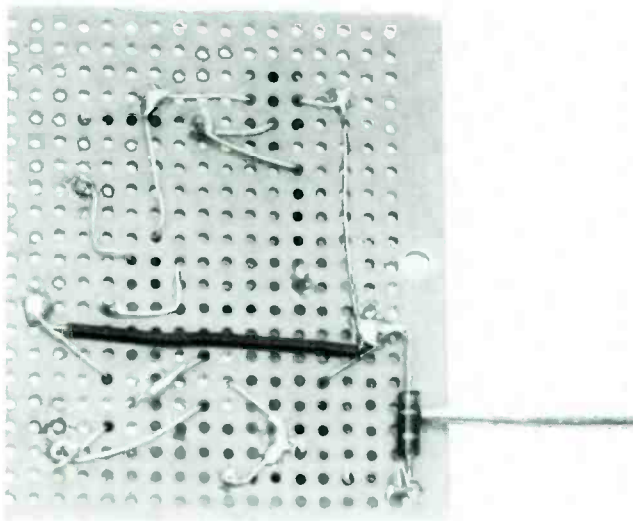
Fig. 1—The transistor designations are not written in stone and you can switch most of them without worry as long as you use the germanium type for Q1 and Q2.



The entire circuit is assembled on a small piece of perfboard. The pointer indicates the solder lug to which all ground connections must eventually connect. The lug will be grounded to the cabinet by its mounting screw.



The pointer indicates one of two *flea clips* used to support the diode. While the component can be mounted by passing its leads through holes in the board, we suggest that the diode, because it is glass, be relieved of all stress by mounting it directly between two clips.



The pointer indicates a resistor mounted on the underside of the board. It makes no difference on which side the components are physically installed. Use whatever works.

## PARTS LIST FOR THE KEYING MONITOR

### RESISTORS

(All fixed resistors are 1/4-watt, 5% precision units.)

- R1—5600-ohm
- R2—50,000-ohm potentiometer
- R3—27,000-ohm
- R4—470-ohm

### CAPACITORS

- C1—0.001- $\mu$ F, ceramic disc
- C2—0.047- $\mu$ F, any type

### SEMICONDUCTORS

- Q1, Q2—2N404A, PNP germanium transistor
- Q3—2N2613, PNP transistor
- Q4—HEP53, NPN transistor
- D1—1N456A, germanium diode

### ADDITIONAL PARTS AND MATERIALS

- B1—1.5-volt, AAA battery
- BP1—5-way, insulated, binding post
- S1—SPST switch, part of R2 (see text)
- SPKR1—8–10-ohm speaker
- Cabinet, perfboard, terminals, wire, solder, battery holder, etc.

and then applied to Q1's base. Transistor Q1 conducts, causing Q2 to conduct. That results in B1's negative terminal being connected to ground, which causes the Q3/Q4 oscillator to sound off. Hence, the oscillator sounds only when the transmitter has been keyed.

### The Cabinet

Absolutely nothing is critical other than using a metal cabinet. The model shown in the photographs uses a 51/4  $\times$  3  $\times$  2 1/8-inch aluminum chassis box. The circuit was assembled on a small section of perfboard with *flea clip* terminals used to provide access for external connections, and to support some critical components, such as diode D1, which might be damaged if it was supported by simply passing its leads through holes in the perfboard.

To avoid the possibility of trashing some components, drill the cabinet and the perfboard mounting holes before installing any parts on the board. Drill a hole for a No. 4 screw centered on one edge of the board, position the board in the cabinet, mark its location, and then drill a matching No. 4 hole in the cabinet.

### Main Ground

A *flea clip* is used to anchor the soldering lug used as the main ground connection. As shown in the photograph, the ground lug eventually connects to the cabinet through the single mounting screw and metal spacer that are used to hold the perfboard to the cabinet. Install the perfboard's ground lug somewhere early in the assembly. Position the lug over the board's mounting hole, and then stake the lug in position with a *flea clip*. Hold the lug in position by tack-soldering it to the *flea clip*. The final solder connection can be made when all the ground connections are made (returned) to the "grounded" *flea clip*.

If you find that lack of experience with wiring perfboard circuits makes it difficult to position all the parts on the same side of the board, or if, try hard as you may, you cannot squeeze all the parts on the same side of the board, simply use

(Continued on page 103)



# GIZMO

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CIRCLE 40 ON FREE INFORMATION CARD

## Alarming Development

**KEEPSAFER PLUS SECURITY SYSTEM. Manufactured by: Schlage, 2401 Bayshore Blvd., San Francisco, CA 94134. Price: \$349.**

Four homes on two coasts in the past decade (two burglaries at one of them); three break-ins at our present apartment; at least two unsuccessful entry attempts discovered after the fact. Losses over the years include a stereo system, TVs, a VCR, watches, loose cash—a fairly typical history (we'd guess) of crimes against our own personal property.

In New York City, police estimated two years ago that there were an average of 400 burglaries per hour in September, with a monthly total of residential break-ins of 10,276.

So there's little mystery as to the explosive growth in electronic-security systems, culminating in both a proliferation of available products and a dramatic take-off in dollar sales totals. Until a few years ago most consumers considered electronic security for their homes to be in the same

category as a wall safe concealed behind a family portrait—strictly out of the movies.

But in common with other kinds of consumer electronic gear, security systems and devices have been created for people who don't live on estates or in mansions. Schlage, a leader in the area of loss prevention, is a long-established brand name in both locks and security equipment.

Their *Keepsafer Security System* with its accompanying constellation of accessories and add-ons is among the best-known of popularly-priced electronic, home-protection products.

GIZMO took a look at the *Keepsafer Plus*, a system which included remote-control operation, three transmitter/sensors, and the master-control console with built-in alarm. In addition, the system was outfitted with an optional backup power supply (No. 71-101, priced at \$19.99). Hailed by one writer as being as easy to install as a stereo, the wireless system requires only a standard slotted screw driver for installation.

The transmitter part of the transmitter/sensors (which is about the size of an electric outlet cover and 3/4-inches deep) fastens to the wall with two screws. Each contains a single 9-volt battery, which the

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sion Tapes, there's also a color analysis test. Here the *hypnotee* is asked to mark his or her ordered preferences from among eight colored boxes.

The amazing color analysis computer back at Potentials Unlimited headquarters in Grand Rapids will grade the test, analyze the results and provide you with printed copy of your mood, personality, and what's happening to you.

What's happening to us as we read this—as we adjust the headphones and insert Konivoc's "I Want to be Happy" cassette into a Walkman—is that we're wondering if maybe the proofreaders back at P.U. headquarters shouldn't have taken a bit more time and put an "a" between the words with and printed, there in the color analysis test literature.

It's a small thing, except for the fact that we are about to let these people very close to the insides of our thought factory and we would rather that they took more care with the language. One misapplied letter can mean the difference between socks and sucks, for instance, which may not seem significant until you're ready to put your shoes on in the morning.

We are, however, pleased as we continue to prepare to be hypnotized, that no gram-

matical errors are found in the "How to Use This Tape" instructions. We're pleased that Potentials Unlimited has taken the effort to warn us concerning the dangers lurking on the spoken side (as opposed to the other, subliminal side) of the tape. Says the warning, "Never play this side of the tape in a car, or when you need to remain fully alert."

We begin to wonder how much alertness is necessary to write this review, but we let the thought pass. We figure it's worth the experiment, listening to "I Want to be Happy" and trying to work at the same time. If we can simultaneously be happy and work, well, look out world and look out warts, acne, war, low bowling scores, and the heartache of hair loss, right?

The key to happiness is found in understanding that when you want, there is never enough, Konivoc says at the beginning. Happiness, then, comes from not wanting. Not wanting to be happy, therefore, brings happiness. And so why have we spent \$9.98 for a cassette tape called I Want to be Happy?

Not long after explaining the key to happiness, which is not-wanting, Konivoc mentions The Handbook to Higher Consciousness. It costs \$4.95. I suggest you

get a copy of this outstanding book, he says. We decide that we very much do *not* want this book, which probably means that we want it. Or not. We begin to breathe deeply, then we yawn.

As we listen, our mind stops futuring just long enough to worry briefly that we've never heard future used as a verb. It's a noun. We're getting picky. And still more sleepy, we're drifting away.

Konivoc tells us that we should focus attention on this, that if you were not demanding what is taking place not to take place, you would not be reacting as you are. We react by taking Konivoc's tape from the tape player and his voice from our now jellied brain. We've had enough. I Want to be Happy is replaced by the *Twelve Greatest Hits of Jimmy Reed*.

Jimmy Reed plays the blues, which is one of our favorite colors of music. The blues usually make us happy and we don't intend to allow the amazing color analysis computer back at Potentials Unlimited the chance to tell us what this means.

You are a truly beautiful person, said Barrie Konivoc, before we woke up.

Says Jimmy Reed, Hush hush—if you don't stop talkin' you're gonna drive me out of my mind.—T.R., C.R.R

## Kiddiecam

**PXL 2000 Deluxe Camcorder System (3305). Manufactured by: Fisher-Price Electronics, 636 Girard Ave., East Aurora, NY 14052. Price: \$225.**

What makes this stripped down and simplified camcorder interesting isn't that it's aimed at kids, but rather the technology used in producing a black-and-white, sound video recording, displayed on a TV or monitor screen inside a black border. The medium used in the PXL 2000—which Fisher-Price calls *Pixelvision*—is a 90-minute, high-bias audio cassette.

While its only current consumer application is this toy camcorder (aimed at kids over 8 years old), as we got to know the system, we couldn't help but think other uses will eventually suggest themselves. The deluxe version of the PXL 2000 includes not only the camcorder and necessary connections (a video switch with antenna adaptor for TV and a video cable), but a 4.5-inches black-and-white TV with AC adaptor. The system's sold with a camcorder stand, six "AA" batteries, and an audio cassette tape as well. Its non-deluxe version (model 3300), doesn't include a television

Besides playback with the supplied TV, the camcorder can be connected directly to a television set. The system's 10 minute



recordings can be transferred to either VHS or Beta formats by connecting the camcorder to a VCR and playing back the audio-tape recorded video image, feeding it to the VCR. The PXL 2000 can even record directly onto a standard VHS or Beta cassette through a VCR. The unit can provide a live video image to a television, but the instructions caution, do not use PXL 2000 in live video mode for extended periods of time as it may damage the internal mechanical components.

The PXL 2000 is recognizably a camcorder, but a simplified, small-fry-size version. Batteries reside in two locations within the handle. The controls include RECORD, PLAY, STOP/EJECT, REWIND (which must be manually held down), and a REMOTE RECORD switch mounted in the rear of the handle. There's a low battery/exposure warning light inside the eyepiece and an indoor/outdoor light adjustment ring around the unit's lens, under which the system's microphone is mounted. Also



on the front is a channel select switch, to set the camcorder at channel 3 or 4 for playback.

We used the PXL 2000 both indoors and out and, not surprisingly, discovered that successful recording requires bright, clear illumination. Indoors, even just outside the circle cast by a 100-watt overhead bulb, recordings were little more than shadows on the screen. Outside, shadows from buildings had an effect on the camcorder's performance. With proper light, however, the resulting video was both discernible and rather intriguing. Pixelvision recordings have a very non-video quality.

Instead, the short, black-and-white segments suggest nothing so much as motion pictures from the very earliest era of movies. Features, even in close-up aren't articulated or sharp. Figures move with an odd, floating motion. A video technician we spoke with called the effect ghosting, and pointed out it's much seen recently in black-and-white concerts, in music videos, and even a few commercials.

Audio performance was mixed. Although the microphone picked up voices and other sounds well enough, it also took

in to a distracting degree the noise of the PXL 2000's motor and tape transport mechanism. The Fisher-Price television is equipped with a sliding channel selector and careful tuning is necessary to properly display the image without the visual distortion of spill-over from adjacent broadcasting channels. Played back on a 19-inch color television, the Pixelvision recording occupied only a centered portion of the screen. Playback on either the supplied mini-TV or the color set produced roughly the same quality of image. Although the instructions explain, the larger the TV screen, the lower the picture resolution appears. Judged as a TV, we'd call the PXL 2000 set merely adequate, but it is a fully operational black-and-white set.

One aspect of the PXL 2000 operation that we didn't like was its remote record button. Apparently some kind of clutch, instructions warn that during recording, the remote record should be turned off. In fact, this is in error. If the remote record isn't turned on, the PXL 2000 won't record at all. Apart from being misled by a mistake in the instructions, we also thought the placement of this toggle-style

switch makes it easy for even adult operators to accidentally engage it.

The system struck us as fragile and not just because of its kid-scale size. The plastic used in fabricating the case is of the usual toy-gauge thickness and strength. While it wouldn't be hard to imagine a kid inclined toward gadgetry or video (the kind of child who takes care of his or her toys) enjoying the PXL 2000, it's also easy to picture a child accidentally jamming the simple but delicate internal mechanism.

But considerations like these aside, we were slightly fascinated by this kidcam. Video buffs of an experimental turn of mind might want to try one of these out, perhaps using it as a special effects adjunct to grown-up video equipment. The PXL 2000 might be useful in applications for which only a low-definition image of short duration is required. The price is certainly right in comparison with the cost of standard video recording equipment.

In the meantime, perhaps Fisher-Price research and development will come up with an improved, expanded PXL 2000. In that event, Pixelvision might not just be for kids.—G.A.



## Chip Chat

**INTEGRATED TELEPHONE ANSWERING MACHINE (FP-M62). Manufactured by: Sharp Electronics Corp., Sharp Plaza, Mahwah, NJ 07430-2135. Price: \$249.95.**

Hello, we're not home right now, but since our answering machine is probably smarter than we are, you won't mind talking to it after the tone. Just kidding, but after wading through the 46-page operation manual that accompanies the Sharp FP-M62 tapeless, digital telephone answering device, we thought this might

make an appropriate outgoing message for the machine.

Although it won't fry bacon or help the kids with their homework, the FP-M62 *Integrated Telephone Answering Machine* does manage to load an impressive combination of functions and features into a very compact instrument. To the extent that its capabilities nearly overshadow the technological advance that makes it new, namely voice-chip technology, telephone message recording without a tape cassette.

The top surface of the unit itself resembles a printed guide to the FP-M62's functions, with controls carefully labeled. But a close reading of the manual reveals that

what's printed on the instrument is only part of the story. In addition to the customary beeperless remote operation for turning the machine on, recording a new message and monitoring incoming messages, the Sharp can transfer messages to another remote answering machine and even make a pre-recorded telephone call to a specified number (a function we predict will make the FP-M62 a plot element in a TV murder mystery real soon).

In addition to the usual outgoing message, this machine can store and repeat a recorded message available only to callers who have been given a private selected message code. Apparently we've entered the era of unlisted telephone answering machine messages.

A flashing red light acts as an incoming message counter, blinking in different patterns to indicate the number of calls received. Beeps heard after playback of a received message give an approximate notion of how long ago the call was made. A single beep indicates less than an hour ago; two beeps, an hour to two hours; three beeps, two to three hours ago. Ten beeps the call was 9 to 10 hours ago, with a single extended beep meaning more than 10 hours ago.

Presumably because of the limited capacity inherent in current voice chip recording (Sharp says the FP-M62 can retain 10 messages 8 seconds in length or 5 messages up to 16 seconds long), the unit has a capacity for a second outgoing, answer-only message. If the user doesn't record

*(Continued on page 6)*



## Humiditarian Award

**TOSHIBA ULTRASONIC HUMIDIFIER (KA-508).** Manufactured by: Toshiba America, Inc., Consumer Products Sector, 82 Totowa Rd., Wayne, NJ 07470. Price: \$120.

It's not the heat, it's the lack of humidity that often makes homes and offices unbearable during winter months. Although humidifiers have been on the market for quite a while, a recent spate of new entries has signaled the devices' increasing popularity, not least of all because they're economical, with discount prices ranging roughly from \$35 to \$90.

Another reason for their widespread use is the relief they provide from a variety of respiratory annoyances caused by breathing air lacking in moisture (house plants, especially the tropical variety, like moist air, too).

Friends who've purchased one of the new ultrasonic humidifiers all sing the units' praises. No longer do they awaken headachy and congested. Alleviated too is the sluggishness that develops from spending long, sedentary hours in an arid office. Although some have qualified this observation by saying that the sluggishness returns for other reasons even after the addition of a humidifier.

Every friend, of course, has advice on the selection, care and maintenance of the mist-producing devices. One worthy tenet goes, the bigger the tank capacity, the better. That's true only in that the humidifier will run longer on a single refill than an equally efficient unit with a smaller water capacity. Other wisdom holds that the humidifier's transducer must be cleaned frequently—at least once a week. That's true, too, but it's a chore easily carried out and some models come with built-in brushes installed expressly for this purpose. One humidifier owner we know even filters the tap water before filling the tank to cut down on the frequency of cleanings. As a time-saving strategy, however, this technique appears a bit self-defeating.

The model we eventually purchased for both home and work is the Toshiba *Ultrasonic Humidifier*, model KA-508, featuring a design, which one visitor described as high-tech. In ads, that model is heralded as top rated, but we were unable to determine the source of this general accolade.

Be that as it may, we've been using the Toshiba at both home and office for well over a month without incident. In fact, it has indeed improved the comfort of both work and home environments, making a night's sleep more satisfying on one front and helping to invigorate an otherwise te-



dious workday on the other. As for our houseplants, they died long ago and were unavailable for comment or reaction.

This Toshiba Ultrasonic Humidifier has a 1.32 gallon (or five liter) tank that at full throttle, runs for about eight hours before needing a refill. It also features two vapor nozzles so the mist can be directed to different parts of the room or concentrated in the same direction. Its other features include a power light, which glows red when the motor is on, and an empty light, which glows green when the device is out of water.

We fully expected the controls, one for mist volume and another for humidity level, to be useless embellishments, much like a thermostat switch on many air conditioners which, while seemingly continuous, have in fact only two basic positions. But the Toshiba's mist volume plainly does control the amount on a graduated scale. Humidity level also adjusts the function it purports to; we decided after observing that the unit consumes less water per hour when the humidity control is set to low than it does otherwise.

Water is turned into mist by the ultrasonic transducer. The mist collects in a plastic reservoir case and is forced out of the nozzles by a fan. As the water level in the system diminishes, it is replenished by water from the holding tank.

Moving the unit full of water, as we did, results in its failure to function properly. A quick look at the instruction brochure informed us that doing this does indeed interfere with the Toshiba's ability to produce and disperse mist. The unit needed to be emptied—a process which involves carrying the base of the Humidifier to the nearest sink and dumping out the water, making sure not to let any get in the

fan housing or intake—and then pushing a reset switch.

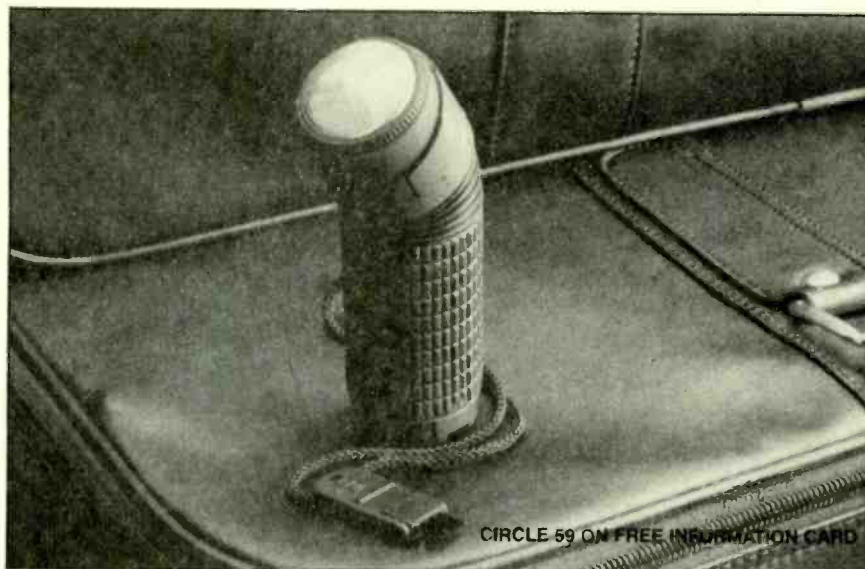
The Toshiba's most admirable quality is its blessed quietness of operation. Set on a solid base—a heavy bookshelf, table or desk—the motor and fan are virtually silent. Only an occasional bubbling can be heard as water enters the system from the holding tank. And at home, while the lone drone of its motor is noticeable, the Toshiba is not in the least disturbing.

One thing the Toshiba consumes aside from water is space, though not an excessive amount considering the use it's put to. The KA-508 requires five feet of headroom, four inches at the rear of the unit and 20 inches from the side in order to take in air freely enough to keep its fan motor from straining.

As its instructions warn, film can form on some surfaces as a result of contaminants being released into the air through the mist. The so-called contaminants—like lime, calcium etc. in the tap water we're better off not knowing about—found their way onto a television screen at our office and onto plastic cassettes and matchbook covers at home. In this situation, Toshiba recommends using softened or distilled water in the Ultrasonic Humidifier and, of course, a thorough cleaning of the transducer.

So, if you've had it with the winter task of nightly refilling decidedly low-tech pans of water on your radiator and you'd like to avoid the annoying winter colds that have co-workers treating you like a leper, consider treating yourself to a more comfortable, healthier environment. It may not do anything to reduce the amount of radon seeping into your basement, but an ultrasonic humidifier will help you breathe a little easier.—G.A.





CIRCLE 59 ON FREE INFORMATION CARD

## The Sound and The Furry

**SOUNDSHAVE WET SHAVER (SS-3).** Manufactured by: Ronde division, Advanced Products & Technologies, P.O. Box 2014, Redmond, WA 98073. Price: \$49.95.

The *Soundshave Wet Shaver's* claim to fame is a novel audio-guidance shaving system. Marketed primarily as a travel accessory, this cordless razor (according to the Ronde brochure) uses sound to guide users to whiskers. In its newest incarnation, *Soundshave Wet (SS-3)*, it not only tells the user where to shave, but offers the tonsorial option of lathered, wet operation.

In comparison with predecessor models, *Soundshave Wet* has been redesigned for high-moisture-content operation. The 10-ounce shaver's cylindrical body has been encased in rubber and outfitted with an articulated shaving head and an exhaust port that creates a flow of water, rinsing the rotating triple blade and ejecting whisker debris. The razor's head can be adjusted to two angled positions in right or left directions.

Pushing the shaving head into either angled position turns on the power, supplied by a single "C" battery. For maintenance, Ronde supplies a small, stiff retractable brush which fastens to a cord anchored to the bottom of the razor. There's also a fitted plastic cap to protect the shaving head when not in use.

We used the *Soundshave Wet* for just over a week both wet and dry and were fairly satisfied until a clerk in a store one morning, unsolicited, asked what had happened to our beard, adding the warning that we shouldn't go anyplace important with that shave. A comment like that kind of destroys confidence in both appearance and appliance, so when we got home we took a close look in the mirror.

The clerk was right. This particular morning the *Soundshave Wet* had left unattractive tufts of whiskers all over our throat and even missed some patches on our face. So maybe we weren't listening carefully to what our razor had told us that morning? Or was it that we just didn't understand what *Soundshave* was telling us?

On its own terms, the *Soundshave Wet* seemed to do a better job wet than dry, although the directions reveal some wet shave restrictions. Although both ordinary

soap lather and foam can be used, the instructions warn against shaving cream, nourishing cream or milky lotions.

We were less than impressed by its dry shave sound advantage. Ronde explains the *Soundshave's* audio guidance in simple terms, *Sound* guides you to whiskers the same way rubbing a credit card, or your hand over the skin does. In other words, if the shaving head (or the credit card) is gliding over bare or smooth skin it makes one kind of noise, crossing into whiskers it makes another. In the case of the *Soundshave*, the audio portion of your morning shave is a highly convincing crackling, cutting noise. The sound of whiskers, presumably, being mowed down and torn into.

On a scale of one-to-ten, we give the *Soundshave Wet* a five in its shaving capabilities and an eight for its overall design. If the shaving traveler is willing to take extra care (preferably in front of a mirror), the *Soundshave Wet* will produce a perfectly acceptable shave. Oddly enough, while not particularly close, we found its shaves consistently comfortable and unscratchy. There was no razor burn (something we've experienced using other new electric razors) and the danger of cutting the skin, thanks to the ultrascreen shield, seems near to nil.

Its overall design, however, is a model of compactness, perfect for travel and comfortable to grip and use. An individual's experience of the *Soundshave Wet* would probably depend on skin and beard characteristics. Off hand, we'd say this would be a fine electric razor for someone with a light beard.

But Ronde's jocular claim that this makes shaving in front of a mirror unnecessary is a trifle overstated. If the *Soundshave Wet* doesn't make contact with whiskers, it doesn't know they're there, which in turn means that unless in front of a mirror, the razor user doesn't know they're there either. Which can produce the kind of shave which causes strangers to ask what happened to your face. An experience which might leave you thinking *Soundshave Wet* makes more noise than sense.—G.A.

### CHIP CHAT

(Continued from page 4)

this second outgoing message and the chip is full, the answering machine mode will be canceled. Users can set the machine to record either 8 or 16 second messages.

A news release from Sharp about the FP-M62 proclaims, digital technology replicates the human voice with such accuracy, it sounds like you're actually answering the phone. this wasn't GIZMO's experience. In fact, a caller suggested as a mes-

sage, we can't answer the phone right now because, as you can hear, we're under water. The odds of mistaking a recorded message for a live human voice when calling this machine seem rather slim. The time limit on outgoing and incoming messages is also potentially a bother.

In recording the outgoing message, a flashing light tells the user when only four seconds remain of either a 16 or 8 second message time. we had to try at least a couple of times before getting the entirety of a simple message onto (into?) the chip.

Even at that, the final version was uncomfortably breathless. Erasing either incoming or outgoing messages is a simple matter of touching an erase button during playback. Score one for tapeless convenience in comparison to conventional answering machines.

In its telephone functions, the FP-M62 offers storage of up to 20 telephone numbers of 32 digits each. There are five auto dial buttons across the top of the telephone keypad and these can store up to five numbers of 16 digits each. To access the larger



capacity auto dial memory, in programming the phone the user selects two digits from the telephone keypad after engaging auto/store. After they've been memorized, the user punches in the two-digit code to automatically dial the number.

We found this dual auto-dial system somewhat confusing. At first it wasn't clear from the instructions that each of the auto-dial buttons stores only one number. To access the telephone numbers stored via the two-digit keypad code route, the caller first must push the auto/store button, then input the two-digit code.

Which means three buttons have to be pushed to dial a seven-digit local call for a total button-pushing savings of four digits. A digit saved, we guess, is a digit saved but it's unfortunate that Sharp engineers didn't bypass all this and figure out a way to have the five auto-dial buttons do all the work.

In its speakerphone function, the FP-M62 has the same limitation as the Execudyne tapeless answering machine/telephone we reported on in June. As a speakerphone, it's more like a walkie-talkie. The unit's user can hear the other person over the speaker, but to respond, the handset must be used. Sharp doesn't even call this a speakerphone capability, label-

ing it instead monitor operation. There's also a hold function, but the instructions don't reveal any time limit on how long a caller can be kept in this electronic limbo. The handset offers a mute button to use when you do not want your conversation or comments to be heard by the other party.

Remote operations, via a user-selected, three-digit access code, includes control of the functions described above, which is the good news. The bad news is that three different triple digit access codes are needed to fully access the functions. A general remote code to listen to incoming messages, change the outgoing message, set the machine to the answer mode. A private select message code in order to hear messages only from callers who know your private select call code, and a third code to access and change the private select outgoing message and to access the unit's capacity to transfer messages to another telephone. To add to the numerical fun, Sharp includes an instructions section on how to change the remote code to use other remote features, that is to say, features usually accessed by dialing another of the system's trio of three-digit remote operation codes.

In ordinary use of the phone we noticed

an annoying tendency on the part of the handset microphone to make sibilant speech sounds (like the "s" or "sh" in "sash") whistle or hiss slightly. On a more-positive note, Sharp is to be commended for a handset with a reasonable heft to it and one which can be comfortably cradled between shoulder and neck.

Overall, we liked using the FP-M62 and we liked its looks. At first glance the instructions are daunting, but the manual is well-organized and charts as simple as interstate highway signs show exactly the sequence to be followed, even when the prose description is a little dense or slightly confusing.

But these features and capabilities would be impressive in a conventional answering machine. The chip makes it possible to pack all of this potential convenience into a very small area. On desk or tabletop, the FP-M62 takes no more space than the traditional non-feature telephone. But it's still hard to believe that any caller would mistake the recorded for the real. In respect to the way it reproduces the sound of the human voice, this compact communications center needs to get bigger.—G.A.

## ALARMING DEVELOPMENT

*(Continued from page 2)*

will beep. Similarly, when you turn the system on in any preset mode, a confirmation beep will follow a few minutes later.

This is one GIZMO test that we're glad wasn't exhaustive. Nobody tried to breach our wireless-security system (at least as of this writing). Having taken the hits outlined above, one aspect of the basic Keepsafer Plus System left us a bit apprehensive. Although loud in decibels, the alarm is short in duration, five minutes according to the guide that's included with the system.

Part of our dreary history of home robbery is going to the neighbors and hearing each of them explain that they heard nothing unusual. That experience makes us long for an alarm that's at least the equal of those that can be heard wailing for intermittent periods on any city street. If automotive alarms are of the long-playing variety, why not a home system that's as persistently noisy?

But, how much home security can you realistically buy for under \$400? Even Schlage may entertain some doubts on that question, given the array of options offered for Keepsafer. First and foremost in terms of upgrading security is a central station service offered for a monthly fee of \$15; a home version of a service offered in retail and other commercial outlets.

That requires the installation of an auto-

matic emergency telephone dialer (model 71-111, \$99.), which connects the system to a national central station, and relays the specific alarm—break-in, emergency, or with optional equipment fire and medical emergency—and where appropriate local services or authorities are immediately contacted. The emergency dialer plugs into a standard phone jack and connects to the console.

It will redial up to 15 times and is transmitted via exclusive phone lines. The option also includes a cancel button, for false alarms, a test button (with two free tests per month), and the unit can automatically clear phone lines to send alarm-code signals. In the event of an alarm, actual human beings from the station call to verify the signal and make direct phone contact with local fire, police, or medical.

Apart from that, Schlage offers some equipment to beef up coverage in the home. Glass-break detector/transmitters fasten directly, and quickly, to windows (model 71-113 \$8.49) and cover a maximum area of 32 square feet. A smoke-alarm monitor (model 71-108 \$59.99) has its own alarm and sets off the console's auxiliary siren. Although it won't make the alarm sound longer, a power siren (model 71-103, \$19.99) makes it louder and alerts the neighborhood with an additional alarm siren in case of a break-in.

An area detector (model 71-110, \$125.99) uses IR to signal the alarm whenever an intruder passes through a

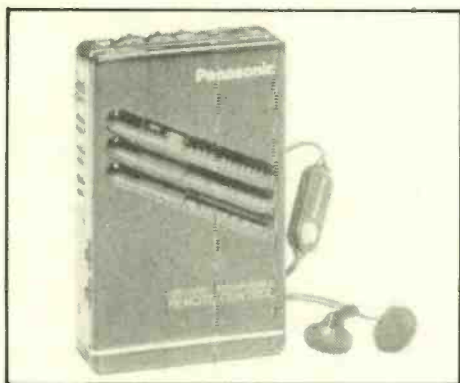
monitored area. That last item may be unsuitable for households with either pets or toddlers on the premise. A handheld bedside alarm (model 71-104, \$25.99) instantly sounds the emergency alarm and sounds a distinctive emergency siren when activated. There's a medical alarm (model 71-106, \$25.99) small enough to wear around the neck or carry in a pocket for use within range of the console. Additional transmitter/sensor sets (\$24.99) and sensor sets (\$5.49) are available.

With the addition of a house-light controller and any number of lamp modules (\$39.99 and \$15.79, each), house lights will immediately turn on, or flash, when alarm is triggered. Even as you read this, we imagine that Schlage is developing further accessories and refinements for the Keepsafer Plus system.

In the distant past, for the lucky-few home security was a matter of stone walls, moats, and drawbridges. The Schlage Keepsafer Plus is a lot less cumbersome (and enormously more affordable), but it's an electronic answer to the same ancient problem (call it progress). And with statistics showing that we can no longer consider, vandalism, burglaries, loss of or damage to personal property, or worse to be the other guys problem, it behooves you to at least look into loss-prevention systems. If GIZMO's Keepsafer Plus is ever put to a real-life test, our readers will be the first to know, right after the police that is.—G.A.



# Gizmo/Bytes



Panasonic Personal Stereo



Thermal Sensor Microwave Oven



Rock'n Roader Truck Speaker



Electronic Copyboard

## Rechargeable Battery Pack Personal Stereo

Just how remote does remote control have to be, anyway? Panasonic Co. (1 Panasonic Way, Secaucus, NJ 07094) calls its new *Personal Stereo Radio Cassette Player* (RX-SA255) a remote control model by virtue of a control mounted on a cord. A fairly complete control, with start, stop, fast forward, rewind and skip reverse (to access the cassette's flip side) all adjusted with a single button. Tape direction memory allows the current direction of the tape travel to be stored after power is turned off. The RX-SA255 comes equipped with a rechargeable battery and charger which provide over three hours of playback per two-hour charge. But its control still doesn't seem especially remote. Price: \$219.95.—G.A.

CIRCLE 41 ON FREE INFORMATION CARD

## Thermal Sensor Microwave Oven

Something new under the increasingly settled microwave oven sun? Could be, but we'll leave it to Goldstar Electronics International, Inc. (1050 Wall St. W., Lyndhurst, NJ 07071) to explain exactly what makes it's new *Thermal Sensor Microwave Oven* (ER-654S) unique. It seems the unit features a thermal sensor cooking system...that senses the humidity of the food—not the temperature in order to prepare foods more evenly. In other words, it's not the heat it's the humidity? In addition, the ER-654S is fully computerized, has 650 watts of cooking power, a ten-position power selector (65 to 650 watts) and, our favorite, computerized keypad with digitron display. Inside the oven, there's a turntable and interior light. The ER-654S's final dazzler is three-stage time cooking including defrost, cook cycle 1 and cook cycle 2, a system which incorporates a ninety-nine minute/ninety-nine second timer and twelve-hour automatic start capability. Price: \$349.95.—G.A.

CIRCLE 54 ON FREE INFORMATION CARD

## Compact "Rock n' Roader" Truck Speaker

Trucks are getting smaller even as they become more popular, including some that are downright mini. Which is why the engineers and marketing people at International Jensen (4138 N. United Pkwy., Schiller Park, IL 60176) put their heads together and came up with a compact addition to the existing line of "Rock n' Roader" Truck Speakers, namely the JTE 602 *Truck Speaker*, designed for use in mini vans, small trucks and hatchbacks. A space-saving 16-inches wide, 10-inches high, and 5-inches deep, the JTE 602 is a two-way ported speaker with power handling capability rated at 50 to 100 watts. Price: \$169.95.—G.A.

CIRCLE 58 ON FREE INFORMATION CARD

## Electronic Copyboard

We don't know what people might do with them, but interested consumers should know that Plus U.S.A. Corp. (10 Reuten Dr., Closter, NJ 07624) is marketing an *Electronic Copyboard* (Kiss-10) at a price under \$2000. Sort of an electronic-age replacement for a blackboard or overhead opaque projector, the Plus U.S.A. Copyboard features a writing surface 51.2-inches by 36.2-inches and requires only 12 seconds to reduce whatever is on the board to a single letter-size copy on heat-sensitive paper. The rig features two-screen reduction capability and random surface movement and can even copy materials merely attached to the board's writing surface. Plus U.S.A. supplies special marker pens in blue, red and black, an eraser accessory and the heat-sensitive roll paper used by the Copyboard in reduction and duplication. The company maintains the Kiss-10 will make the Electronic Copyboard a staple in offices and classrooms. If the price comes down in the future, some appliance manufacturer will probably offer a refrigerator with an electronic copyboard built into the unit's door. Price: \$1,995.—G.A.

CIRCLE 82 ON FREE INFORMATION CARD

## Auto SunCharger

As long as the sun's in the sky, you'll never be stuck with a dead car battery again, promises the description of the *Auto SunCharger* in the Syncronics Catalog (Hanover, PA 17333-0042). Looking oddly like an electric griddle, the charger mounts on the vehicle dashboard or window and plugs directly into the cigarette lighter or fuse box. Harnessing the power of the sun, it replaces the energy drained each day from a standard 12-volt auto battery. Rated at 70 to 90 amps under full sunlight, the SunCharger features an LED charge indicator and, according to Syncronics, makes starting quicker and easier while providing power to maintain computerized components. Price: \$39.95.—G.A.

CIRCLE 61 ON FREE INFORMATION CARD



## Easy Keypad MultiFunction Telephone

Combination is sometimes a key to design innovation. A new *Multifunction Phone* (7383) from Soundesign Corp. (Harborside Financial Center, Jersey City, NJ 07302) brings together sophisticated capabilities and an easy-to-use, oversized keypad. Accusing other multifunction phones of crowding together lots of small buttons on the handset, the Soundesign 7383 incorporates large and readily distinguishable colored function buttons along with an easy-viewing tilted angle when desk-mounted. The phone's detachable base with non-skid rubber feet can also be wall-mounted. Besides leaving plenty of room for both small and large hands to operate the phone, the 7383 features 20-number memory, including four one-touch numbers, a simplex speakerphone, a hold button with LED indicator, automatic hold release, and a pause button which allows users to momentarily halt the storage sequence during the spaces between confirmation beeps, providing quicker dialing sequence once the number is stored in memory. The telephone is available in black, gray, or ivory, and comes equipped with 7 ft. line and coiled handset cords. Price: \$49.95—G.A.

CIRCLE 42 ON FREE INFORMATION CARD

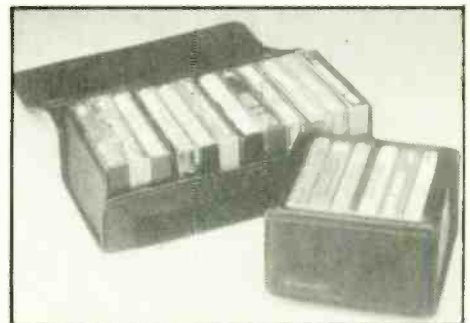


Easy Keypad MultiFunction Telephone

## Audio Cassette Storage Case

Still in need of a convenient way to store audio tapes at home or on-the-go? That's just the consumer need that Discwasher (4310 Transworld Rd., Schiller Park, IL 60176) aims to meet with two new *Cassette Storage Cases*. Available in six and one dozen-unit models, the cassette cases feature a water-resistant vinyl finish, a see-through window on the top and Velcro-style fasteners. Price: \$7.95—\$14.95—G.A.

CIRCLE 64 ON FREE INFORMATION CARD

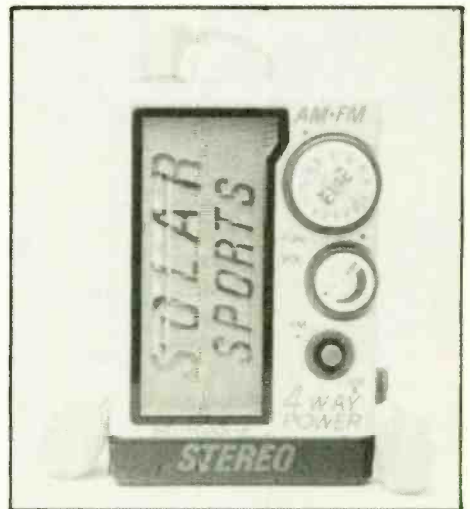


Audio Cassette Storage Case

## Solar-Powered AM/FM Radio

According to Solar Electric (175 Cascade Ct., Rohnert Pk., CA 94928), its new *Solar Sports Radio* is the world's first practical solar radio, meaning owners may never have to buy batteries again! In any event, it features AM/FM reception, earphones, water-resistant case and high quality stereo sound. The Solar Sports radio uses a solar cell which can power it directly or recharge its built-in battery. Price: \$59.95—G.A.

CIRCLE 56 ON FREE INFORMATION CARD



Solar-Powered AM/FM Radio

## Illuminated Rechargeable Peppermill

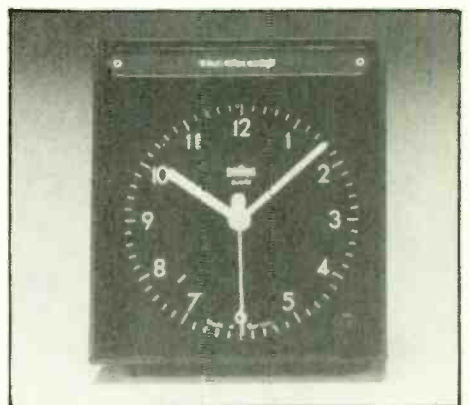
Whoever designed the *Illuminated Rechargeable Peppermill* must have had in mind those restaurants where it's too dark to see what's on your plate. Whatever the inspiration, Hammacher Schlemmer (149 E. 57th St., New York, NY 10022) is offering this unusual culinary item for home consumption. The mill grinds a measured amount of peppercorns at the touch of a button while it illuminates the plate. The grinding mechanism is by Peugeot and includes a gold-plated adjustment collet which controls six different grind settings. There's even a grinder door which responds to a heat-sensitive control button, closing when the mill is set down. Power for this deluxe grinding operation is from five NiCad batteries (included), rechargeable via a 12-volt storage base. The peppermill is 11 $\frac{1}{8}$ -inches tall and weighs in at 2 $\frac{3}{4}$  lbs. Not, we judge, for the casual pepper user. Price: \$149.95—G.A.

CIRCLE 57 ON FREE INFORMATION CARD

## Reflex Control Alarm Clock

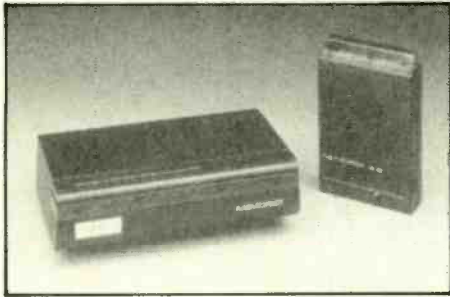
Here's a product which probably had its origins in everyday experience. Have you ever groggily awakened to waving your hand at a ringing alarm clock, in the dream-like hope the sound will stop? Braun, Inc. (66 Broadway, Rt. 1, Lynnfield, MA 01940) has a new *Reflex Control Alarm Clock* (AB 50RSL) that does just that. An infrared sensor on the front of the clock detects the motion of your hand when you wave away the alarm to snooze. The same motion also illuminates the dial. The alarm repeats at four-minute intervals, to shut it off completely it's necessary to touch a control bar. The AB 50RSL features a quartz movement, side-mounted alarm setting and increasing alarm volume. Price: \$49—G.A.

CIRCLE 46 ON FREE INFORMATION CARD



Reflex Control Alarm Clock

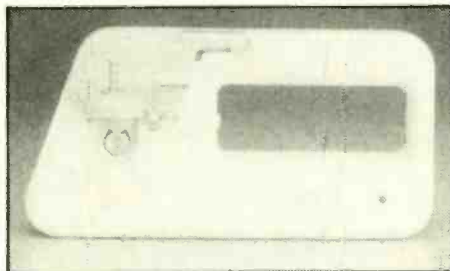
# Gizmo/Bytes



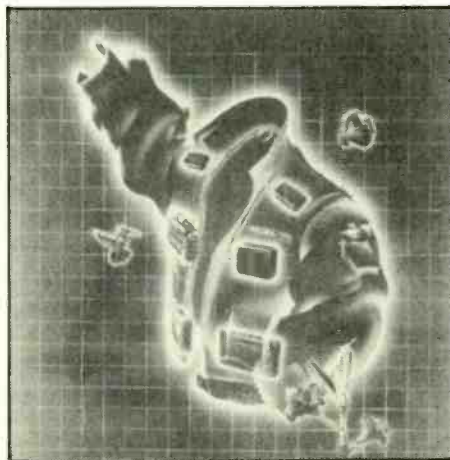
Cordless Stereo Headphone System



Goldstar Dehumidifier



Cordless Can Opener



Toshiba's Sonic Jacket

## Cordless Stereo Headphone System

Consumers certainly resent the miles of cords and connections their contemporary electronic lifestyles come wrapped in. At least they seem to, based on all the cordless products regularly which come down the pike, like the new *Cordless Stereo Headphone System* introduced by Memtek Products (P.O. Box 58118, Santa Clara, CA 95052-8118). The freedom of enjoying musical favorites and TV program sound without being tied down, is attained with a lightweight infrared receiver (small enough to be hooked to a belt or put into a pocket) picks up true stereo signals from the output source, and can be used with any headphones or earphones. The other half of the system is an infrared transmitter which connects to any audio or video component via the headphone/audio out jack. The system achieves a range of 20 feet and a mute function is automatically activated when the receiver goes out of range. Price: \$89.99—G.A.

CIRCLE 45 ON FREE INFORMATION CARD

## Dehumidifier

OK, the popularity of humidifiers is obvious, but what about their opposite number? Goldstar Electronics International, Inc. (1050 Wall St. W., Lyndhurst, NJ 07071) doesn't seem to have any doubts. The company has just introduced its first line of *Dehumidifiers*, including the top model, the GDH-250D. The unit can remove up to 40 pints of moisture from the air in a 24-hour period, features an automatic "dehumidistat" defrost control and a full indicator to tell users when its 22-pint capacity drain reservoir should be emptied. The unit measures 12.6-inches wide, 16.6-inches deep and 20.5-inches tall. Price: \$299.95—G.A.

CIRCLE 60 ON FREE INFORMATION CARD

## Desktop Massager

This might be the electronic age equivalent of worry beads. According to The Sharper Image (650 Davis St., San Francisco, CA 94111), the *Desktop Massager* is quiet enough to use anywhere and should be taken with the user, wherever tension is likely to strike, meetings with the boss, traffic jams, standing in line at the market. Weighing a mere 3 oz., beneath the cap of this 3-inches tall cylinder is an egg-shaped orb which, when pressed to the skin creates a pleasurable, relaxing vibration wherever you place it. The unit's electric motor is powered by a single "AAA" battery. Price: \$26.50—G.A.

CIRCLE 69 ON FREE INFORMATION CARD

## Cordless Can Opener

This appliance isn't solar-powered, but it is cordless; a 2-watt, white-with-gray accents *Cordless Can Opener* (CCO-200) from Conair Corp. (1 Cummings Pt. Rd., Stamford, CT 06904). The unit features direct plug-in recharging. Simply plug the cordless can opener into any ordinary household outlet. In action, the unit opens cans in seconds, with just the press of a thumb. The cutting mechanism can be detached for washing, while the opener's slim shape makes it easy to store in kitchen drawers or stow in a backpack or aboard a boat. Price: \$28.95—G.A.

CIRCLE 48 ON FREE INFORMATION CARD

## Sonic Jacket

If cordless listening doesn't appeal, how about a *Sonic Jacket*? With this product from Toshiba America, Inc. (82 Totowa Rd., Wayne, NJ 07470), the listener wears the audio source. The garment incorporates four speakers, a stereo amplifier, a battery pack and color-coded wiring assembly. The speakers are tucked into the jacket's shoulder-level audio compartments, with bass located at chest level. The stereo amplifier (Toshiba doesn't say where that's located) requires four "C" batteries and can accommodate either a radio cassette player or portable CD player. The company says the Sonic Jacket is the result of sophisticated acoustic principles, the cybersonic effect is mentioned, and as a result it supplies the wearer with music reproduction of unusual immediacy and impact. The windbreaker-style jacket, a cotton/polyester blend, features removable sleeves and is available in three sizes. Price: \$200—G.A.

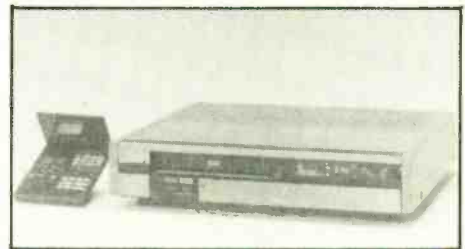
CIRCLE 66 ON FREE INFORMATION CARD



## Super VHS Digital VCR

If you've been waiting for the ultimate in digital home video, the *Super VHS Digital VCR* (HR-S8000U), is the model you've been holding out for, at least so far as its manufacturer, JVC Co. of America, (41 Slater Dr., Elmwood Pk., NJ 07407) is concerned. Besides being a deck designed for those who want the best, the HR-S8000U includes such special effects as digital zoom which lets the viewer enlarge the center quarter or any corner of the screen to full-screen size, freeze, strobe and, of course, picture-in-picture. A function dubbed multi-screen intro search automatically locates all the index coded programs on a pre-recorded tape and sequentially displays a still picture from the beginning of each program, either on a sub-screen or in either 4, 9 or 16-frame multi-screen mode. Other digital effects include coloration and mosaic, which lets the user create fascinating video art. The HR-S8000U's remote is a unified VCR/TV control, capable of operating all digital effects as well as timer programming, either in conjunction with on-screen display or via the control's LCD display. Remote control can program memories for up to four events [which] can be transferred any time to the VCR memory. Although only designated TVs are fully controllable (power, channel selection, volume and A/V mode) via the remote, other sets' volume is adjustable with the unit. All this and more, plus an attractive cabinet of simulated oak. Price: \$1,599—G.A.

CIRCLE 43 ON FREE INFORMATION CARD

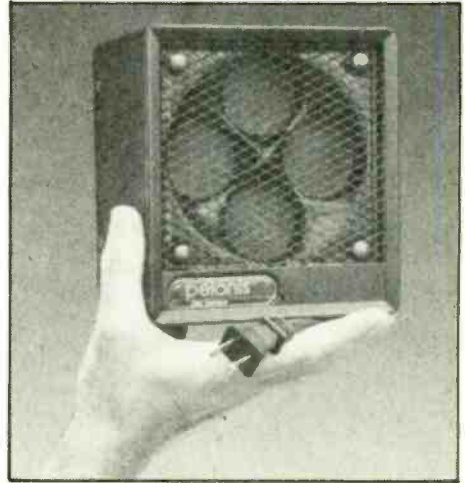


JVC Super VHS Digital VCR

## Pelonis Disc Furnace

It's a trifle unseasonal but if you're thinking about heaters for winter the *Pelonis Disc Furnace* from Olympus Marketing Associates, Inc. (460 Carborundum Center, Niagara Falls, NY 14303) might merit some attention. It's an extremely compact unit and its patented ceramic honeycombed disc heating element allows operation at much lower temperatures than conventional coil heaters. A temperature, according to the distributor, below the combustion point of even tissue paper. Other features include thermostatic control, a five-blade fan, electronic control assembly, an air filter and a five-year limited warranty. Price: \$169—G.A.

CIRCLE 51 ON FREE INFORMATION CARD

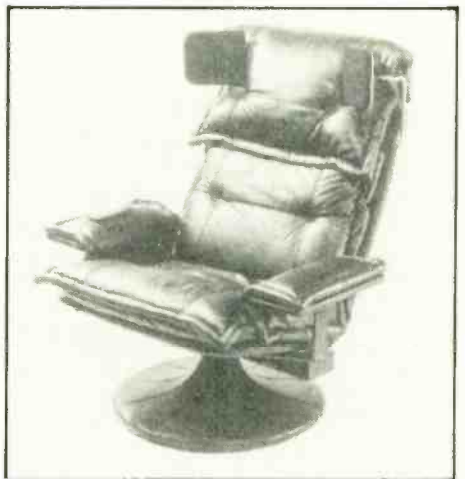


Pelonis Disc Furnace

## Bodysonic Surround-Sound Chair

Of course, if you don't want to listen wirelessly or wear your audio sources, you could always sit on it, at least with a new deluxe item from Pioneer Electronics (USA), Inc. (2265 E. 220th St., P.O. Box 1720, Long Beach, CA 90801-1720), the *Bodysonic Surround-Sound Chair* (BSS-F1). This black leather chair produces nothing less than a dynamic sound-vibration combination when connected to audio or video components. Connected to a surround-sound amplifier or processor, the BSS-F1's speakers function as part of the system, eliminating the need for additional rear-channel speakers. Incorporating a stereo and Bodysonic amplifiers, this audio/physical component has a power consumption of 50 watts and, according to Pioneer, delivers a combination of sound and vibration that some studies have shown may be beneficial in producing deep rest and relieving the stress of daily living. Best of all, you won't have to keep feeding it quarters. Price: \$2,000—G.A.

CIRCLE 47 ON FREE INFORMATION CARD



Bodysonic Surround Sound Chair

## FM/AM Telephone Clock Radio Answering Machine

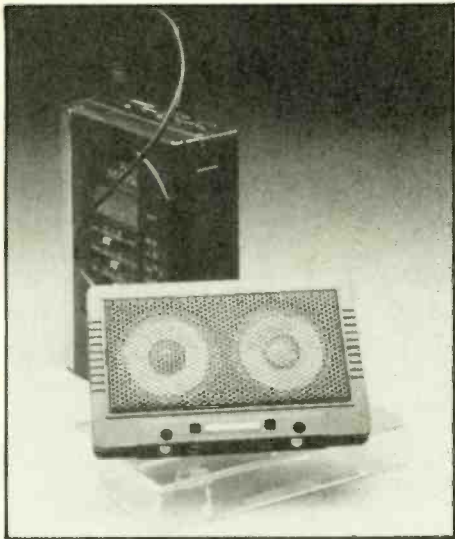
We're a little surprised they didn't include a mini-TV set with this item from the Panasonic Co. (1 Panasonic Way, Secaucus, NJ 07094). The RC-TX91 is an *FM/AM Telephone Clock Radio Answering Machine* with the added convenience of timer message transfer, which allows the user to program a message to be sent to a specific number at a particular time, even using the answering machine's beepless remote capability. The RC-TX91's answering machine also features time stamp, a visual display of the time a message on the tape came in. The unit's telephone features speakerphone and hold operations, automatic dialing (for up to 16 30-digit numbers) and pause and flash functions. The clock radio's perfect sure alarm keeps the correct time in the event of a power failure or shut-off, in addition the alarm will sound if power fails. The radio automatically mutes its volume when the phone rings. Price: \$249.95—G.A.

CIRCLE 67 ON FREE INFORMATION CARD

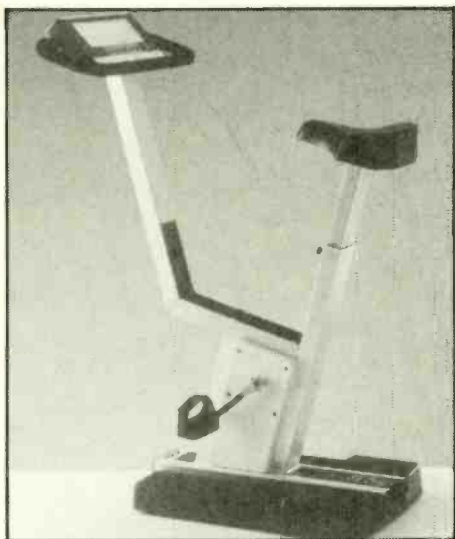


FM/AM Telephone Clock Radio Answering Machine

# Gizmo/Bytes



Speakermate Mini-Speaker



Stationary Cycling Simulator



Braun Juice Extractor

## Baker Street VCR Game

There was no home video entertainment system at 221 B Baker Street in London, a century ago the address of fiction's most famous sleuth, Sherlock Holmes. But that hasn't stopped VCR Enterprises, Inc. (5 W. 37th St., 8th fl., New York, NY 10018) from introducing *VCR 221 B Baker Street Game*, a cassette which presents 10 original episodes in the life of Sherlock Holmes and Dr. Watson in a presumably open-ended form suitable for individual, group or team play. Each episode comes with a detective checklist, quick quizzes and special playing cards enabling participants to solve each case. Price: \$44—G.A.

CIRCLE 44 ON FREE INFORMATION CARD

## Cassette-Style Mini Speaker

Tiny speakers for use with various Walkman-style units have been around for some time, but Memtek Products. (P.O. Box 5811B, Santa Clara, CA 95052-8118) has come up with a novel variation on the theme. Its new *Speakermate Mini-Speaker* looks exactly like an audio cassette and comes with its own case, so it can be stored along with actual audio cassettes. Sold with a 17-inch cord, the speaker weighs 4 oz., connects to any personal stereo and can be used as a tabletop speaker or attached to the tops of most personal stereo units for mobile use. Price: \$19.95—G.A.

CIRCLE 52 ON FREE INFORMATION CARD

## Automatic 35mm Telephoto Lens Camera

Point and shoot 35mm photography now includes the first all-weather camera to feature a built-in 40mm wide angle/60mm telephoto lens. This development comes from Konica U.S.A., Inc. (440 Sylvan Ave., Englewood Cliffs, NJ 07632) in the form of its newest *Automatic 35mm Camera* (MR.640). Powered by a lithium battery, the MR.640 is completely automatic and features quick-charge auto flash, 18-step autofocus and a built-in wide angle/telephoto lens. A power switch allows the user to see both telephoto and wide angle, while the camera's automatic exposure system sets correct exposure and automatically turns on the built-in electronic flash if needed. There's also a skylight filter, protecting the lens from water, dirt and scratches, as well as eliminating or reducing the black shadows from pictures taken in bright sunlight. An LCD shows number of frames remaining, flash mode and battery power status. Price: \$345—G.A.

CIRCLE 65 ON FREE INFORMATION CARD

## Stationary Cycling Simulator

Here's a piece of exercise equipment that promises to take the user for a real ride. From Precor USA. (20001 N. Creek Pkwy., P.O. Box 3004, Bothell, WA 98041-3004), the *Cycling Simulator* (M8.7sp) features vivid 3-D graphics, with a choice of over 30 different courses against three different scenic backdrops; hills of San Francisco, mountain and desert routes, including race situations with up to seven pace riders. The screen can display, in addition to 3-D, split-screen, profile and top-down views. In competitive programs, the readout tells the exerciser what his or her race position is second by second. A previous race can be stored in the Simulator's memory and exercisers can race against them. A single touch controls the unit's gear ratio (making for easier or more strenuous pedaling). Data is shown in numerical and graphic forms. LCD readouts display elapsed time, miles per hour, pedal rpm's, calories per minute and total calories burned. Price: \$2,000—G.A.

CIRCLE 70 ON FREE INFORMATION CARD

## Juice Extractor

It takes a heap of pulp to make a glass of juice, which is probably why Braun, Inc. (66 Broadway, Rt. 1, Lynnfield, MA 01940) outfitted its new premium model *Juice Extractor* (MP80) with a 400-watt motor. Other features of this top-of-the-line appliance include automatic pulp ejection with a swing-out container. A specially designed beaker helps eliminate foam. The MP80 also has a unique tray which inverts for easy loading of fruits or vegetables and stores on top of the unit when not in use. Price: \$80—G.A.

CIRCLE 68 ON FREE INFORMATION CARD

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# AQUISENSE

An inexpensive freezer monitor  
with an unusual thaw/freeze sensor



By Tom Fox



**W**HEN IT COMES TO KEEPING PERISHABLE ITEMS (meats, poultry, certain dairy products) fresh, nothing beats the freezer. Unfortunately, doors get left open by both active children and scatter-brained adults, often leaving behind a yucky mess. How often have you gone to the frig for a much-deserved dish of your favorite ice cream, only to find an empty ice cream container surrounded by some goop that resembled malted milk? A disappointing discovery, to say the least.

Have you ever wished that there was some simple device that would alert you to the “disaster” before it occurs? Well read on and find out how *Aquisense* can help you to do just that. While the circuit costs only a few bucks to put together, *Aquisense* can save you a bundle of *Ben Franklins*!

*Aquisense* is capable of monitoring a freezer (or freezers) and will sound an alert well in advance of the temperature rising enough to cause the strawberry ice cream to change to pink yuk! It will also warn you if the weatherman’s forecast of “scattered showers” is threatening to turn your basement into an indoor swimming pool.

The circuit’s sensing device (see photos)—the most important part of the project—is a cinch to make, using inexpensive and readily available materials. And the fact that it has a few idiosyncrasies make it all the more interesting to those who love to build from scratch!

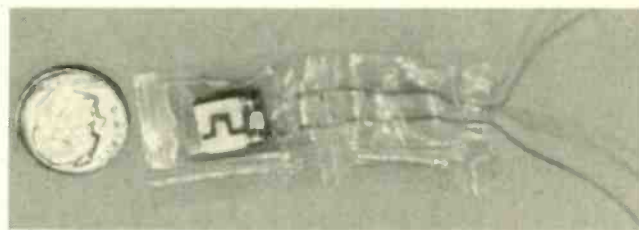
While an alarm from *Aquisense* might suggest a defective freezer, some of the more-likely causes are a freezer door left open, an unplugged power cord, a blown fuse, or a general power outage. You might be thinking, “What darn good is a thaw alert if the power goes out?” Well first off, *Aquisense* is battery operated; so blackouts and brownouts do not affect its operation.

Second, if the alert doesn’t go off during the blackout, one can be reassured that frozen foods are still fresh and tasty. Finally, if *Aquisense* does go off and the power doesn’t come on for another day or so, though the food might not be yucky yet, it probably isn’t suitable for refreezing. That knowledge might save you a horrendous tummy ache some day.

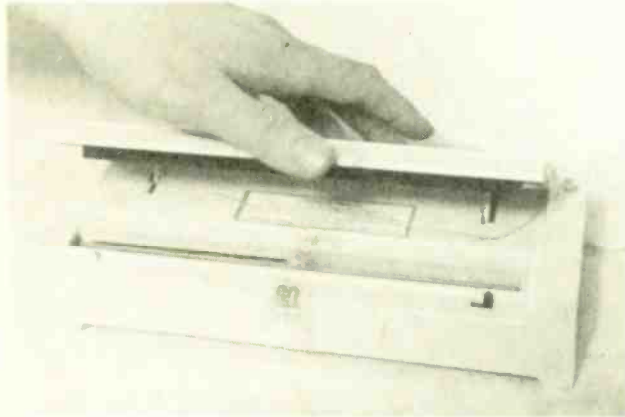
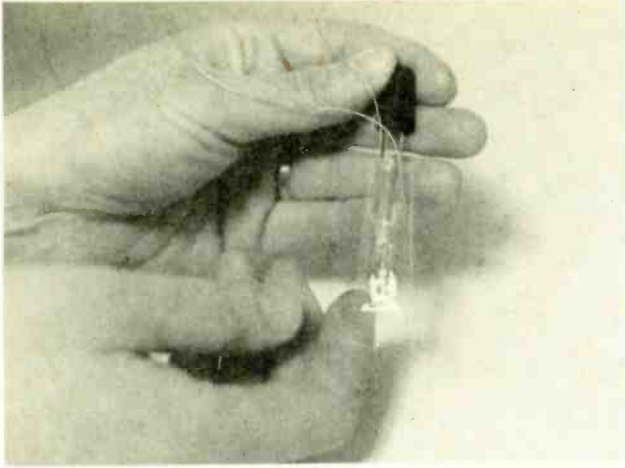
With the addition of another homemade sensor, *Aquisense* will inform of a “rising tide” in the lower levels of your home (basement flooding) or in any area in which the sensor is placed. Another neat feature of the circuit is its simple, built-in battery/circuit tester.

## A Bit of Background

I first came up with the idea of using water in a freeze/thaw sensor a while back. A few simple experiments with an ohmmeter showed that the idea had possibilities. Discovering that the resistance of water in its solid state (ice) is much greater than the resistance of water in its liquid state, I



Many possibilities exist for the sensor’s construction. One, using a burnt-out transistor, was mentioned. But a somewhat different one (pictured here), was used by the author in the construction of the *Aquisense*. Notice that it’s simply a small printed-circuit board, with conductive parallel strips, sealed in a plastic bag.



The author used a Dazey Seal-O-Meal along with a boilable heat-sealable bag to encapsulate the sensor. Prior to sealing the bag a drop or two of water was placed into the envelope using an eyedropper. If you can't locate a Dazey Seal-O-Meal, a laundry iron may do the trick. If you use an iron make sure that the bag is isolated from the iron's surface by a pressing cloth or similar material.

decided to attempt to make a simple frost alarm that was based on that principle.

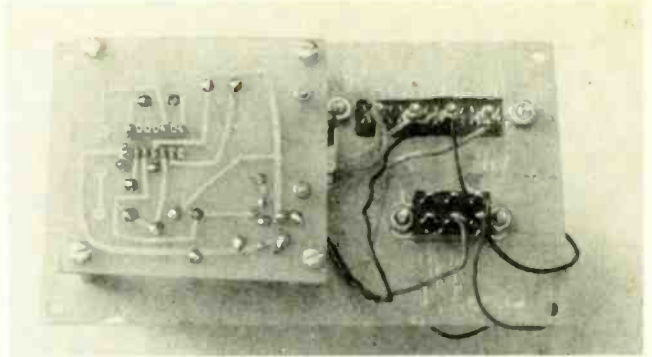
The sensor, I decided, should be very small. My initial sensor design consisted of a burnt-out transistor with a tiny hole drilled in its metal case. The transistor was then filled with water and the tiny hole sealed with cement. With the use of an ohmmeter, I came up with the kind of readings that I'd expected. When liquid, the ohmmeter showed several thousand ohms of resistance between two leads.

However, after placing the sensing device in the freezer for a short time, the ohmmeter would show nearly an open circuit. Using that information, I designed two simple circuits. The circuits worked, but not that well.

The primary problem was that the resistance of the thawed sensor appeared to increase with time—apparently due to a plating action. Because of the plating problem, a true prototype was never completed.

Then, more recently I began experimenting with rain-detecting circuits. I noticed that if it snowed at night and the temperature dipped below freezing, the circuit would not indicate rain. But, when the sun came up the next day and melted the snow, raising the sensor temperature a bit, the circuit signaled rain. Slowly I focused on the true meaning of that apparent phantasm.

A frozen water (ice) freeze/thaw sensor!—all that was needed was a way to maintain water about the sensor plates



After Aquisense's printed circuit was completely assembled the author mounted it (on stand-offs) to the cover of his project box, along with the off-board components.



A screw-type terminal strip with 4 terminals was mounted to the cover plate of the enclosure, and divided electrically into two sets (each set having 2 terminals, which are connected in parallel). The terminal strip serves the connection point for SEN1 and SEN2, and also provides a simple method of checking the battery's ability to power the circuit as well as indicate whether the circuit is operating. To check the battery/circuit, simply touch two terminals with a wet finger. If the circuit is operating correctly, the buzzer should sound off.

without it evaporating. With new energy and an abundance of optimism, I set out to make a new updated version of my homemade freeze/thaw sensor, this time using it in a thaw-alert circuit.

The homemade thaw sensor consists of two electrically conducting contacts immersed in a trace of water and separated by a short distance. At temperatures above water's freezing point, the resistance between the contacts is several thousand ohms.

Said resistance increases to tens of megohms at temperatures below the freezing point. Many possibilities exist for the sensor's construction. One, using a burnt-out transistor, was mentioned earlier. But a somewhat different one, the sensor used by the author in the construction of the Aquisense, is shown in the photos. Notice that it's simply a small printed-circuit board, with conductive parallel strips, sealed in a plastic bag.

### Inside the Circuit

Figure 1 shows the schematic diagram for Aquisense, which is comprised of an LM1830 fluid detector (UI), a home-brew sensor (SEN1), and a few support components. The simplicity of the circuit is due in part to the homemade temperature sensor, which is pre-calibrated by physical laws to switch on and off at the freezing point of the water within the sensor housing. Thus, no calibration is needed!



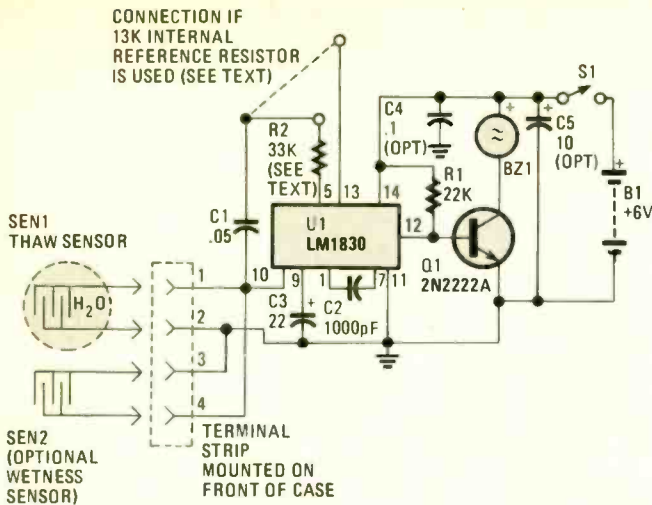


Fig. 1—The schematic diagram for Aquisense shows that it is comprised of little more than an LM1830 fluid detector (U1), a home-brew sensor (SEN1), and a few support components.

Another reason for the circuit's simplicity is the LM1830 fluid detector, which contains an oscillator, detector, op-amp-feeding an output transistor, bias network, and reference resistor (see Fig 2). U1's primary advantage over simple transistor-detection circuits is that it uses an AC signal to overcome the plating problems caused by a DC source.

The frequency of U1's internal oscillator is dependent on C2 (in this case a 1000-pF capacitor). With a capacitance of 1000-pF (0.001-μF) for C2, the frequency of oscillation is about 6000 hertz (6-kHz). Notice that both pins 5 and 13 are oscillator outputs. Pin 5 is directly connected to the output of the internal oscillator, while pin 13 has a 13K internal reference resistor in series with the oscillator's output.

For many applications, one simply connects a .05-μF DC blocking capacitor (C1 in Fig. 1) between pin 13 and pin 10 (pin 10 is the detector input). Pin 5 here is left unconnected. That setup makes use of the internal 13K resistor. Other circuits, such as the one used in Aquisense, use an external reference resistor.

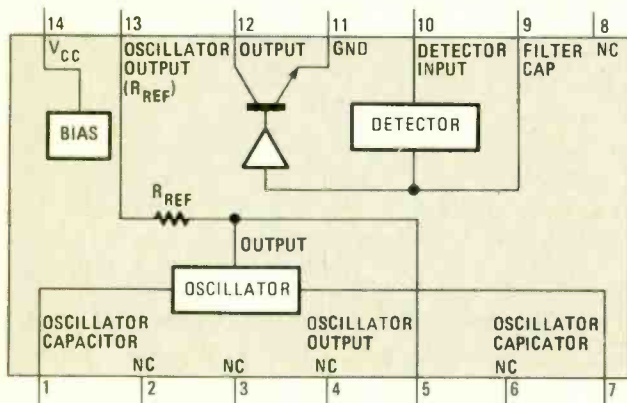


Fig. 2—The LM1830 fluid detector contains an oscillator, detector, op-amp-feeding an output transistor, bias network, and reference resistor, as shown in this block pinout/functional diagram. It's primary advantage over simple transistor-detection circuits is that it uses an AC signal to overcome the plating problems caused by a DC source.

The sensor itself is connected from pin 10 to ground. When the resistance of the sensor exceeds that of the reference resistor, U1's internal output transistor turns on, effectively

## PARTS LIST FOR THE AQUISENSE

- BZ1—5-10-volt low-power buzzer
- C1—.05-μF ceramic disc capacitor
- C2—1000-pF, 16-WVDC electrolytic capacitor
- C3—22-μF, 16-WVDC electrolytic capacitor
- C4—.1-μF, ceramic disc capacitor
- C5—10-μF, 16-WVDC electrolytic capacitor
- R1—22,000-ohm, ¼-watt, 5% resistor
- R2—33,000-ohm, ¼-watt, 5% resistor
- U1—LM1830 fluid detector, integrated circuit

Printed circuit or perfboard materials, terminal strip, enclosure, IC socket, battery and battery holder, wire, solder, hardware, etc.

short circuiting pin 12 (the output pin) to ground. (Note that both the schematic in Fig. 1 and the circuit board, Figs. 4 and 5, show the option of using an external or internal reference resistor.) The purpose of capacitor C3 is to filter the output voltage so that the output switches "on" or "off." In some circuits that filter capacitor is not used.

In Fig. 1, notice that a 33K external-reference resistor is used. While in most cases, the internal 13K resistor can be used, a more reliable design is to use an external reference resistor, with a somewhat higher resistance than 13K. Summarizing briefly, the circuit operation of Aquisense, under normal operating conditions, the water in SEN1 is frozen, making SEN1's resistance extremely high. Since the resistance between pin 10 of U1 and ground is significantly above 33,000-ohms, U1's output transistor is turned on, resulting in pin 12 being close to ground potential.

Since pin 12 (the collector of U1's internal output transistor) is connected to the base of Q1 (placing it at ground potential), Q1 is cut-off causing its collector to act as an open circuit. Thus the buzzer is silent.

When the water in sensor SEN1 starts to melt, its resistance drops significantly, causing U1's internal transistor to turn off and pin 12 to be effectively an open circuit. With the internal transistor turned off, some small current is applied to the base of Q1 (via R1), turning it on. That provides a ground path through Q1, completing the buzzer, causing the alarm to sound.

## Makes Sense To Me

The sensor itself is made from a small piece of copper-clad, printed-circuit board material, as illustrated in Fig. 3. The simple foil pattern is shown in Fig. 3A. Since the size of the board isn't critical, dimensions are not given. Nonetheless, it seems logical to assume that a small sensor will be more sensitive than a larger one. Because of that (and to save some pocket change), it's probably wise to make the sensor as small as possible.

The board can be either single-sided or double-sided—with double-sided being the author's choice. For such a simple circuit, draw the foil pattern directly on the printed-circuit material (foil side) with a fine-tipped, black permanent marker. Such a pen is available at many supermarkets or hobby-electronics outlets.

After the circuit board has been etched, wires must be attached to the board's contacts (see Fig. 3B). Since the sensor is to be sealed in a heat-sealable bag, use as fine a bare wire as you can so that the seal will be watertight. For instance, you can use single strands taken from a stranded wire. (The thickness of wire the author used in his sensor was .006-inch.)

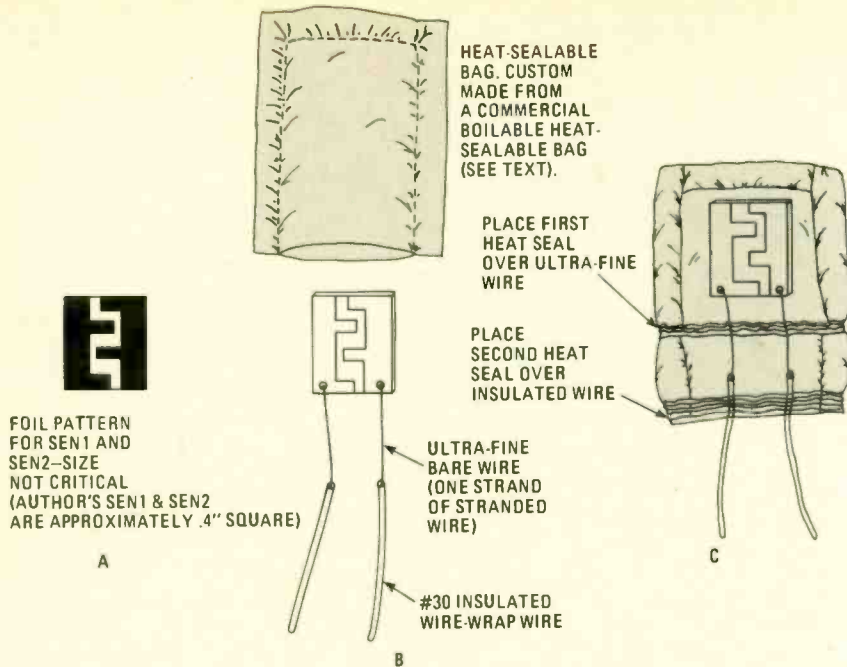


Fig. 3—The sensor is made from a small piece of copper-clad, printed-circuit material. The simple foil pattern is shown in "A." Once the board is etched, wires are attached to the contacts as shown in "B," and sealed in a heat-sealable bag, as illustrated in "C."

Referring to Fig. 3C, notice that the ultra-fine bare wire is cut off at about 1 to 1-½ inches from the board and lengths of a heavier insulated wire are soldered to its end. The author used #30 insulated wire-wrap wire. The ultra-fine bare wire allows a nearly perfect seal. The heavier insulated wire increases the ruggedness of the sensor.

To seal the sensor, the author used a Dazey Seal-O-Meal along with a boilable heat-sealable bag. The bags are tough! Freeze 'em hard and toss 'em in boilin' water and they emerge without a leak (at least that's what they are designed to do). Boilable heat-sealable bags are available in the kitchen-ware section of department stores. If you can't locate a Dazey Seal-O-Meal, a laundry iron might work. If you use an iron make sure that the bag is isolated from the iron surface by a pressing cloth or similar material.

Since even the smallest bag available is far too large, you will want to make your own bag by cutting to size and sealing. For the basic material, use a small commercially-available, boilable heat-sealable bag. Make sure you leave one end of the bag open. See Fig. 3B.

Before inserting the sensor's printed-circuit board into the bag, rinse it off with warm running water for at least a minute. That removes some of the impurities that might be present. Insert the tiny sensor board into the bag as far as it will go. Make sure that the bare leads are not touching and the insulated wire exits from the bag (see Fig. 3C).

Using an eye dropper filled with clean tap water, place 1-to-3 drops of water next to the board. Referring to Fig. 3C, seal the water in the bag at the point labeled "First Seal." Be sure that the first seal is made over the ultra-fine bare wire. If you are using the Dazey's Seal-O-Meal, press down on the sealer for 10-to-15 seconds. Again refer to Fig. 3C for the location of the second seal. The second seal's primary purpose is to provide mechanical strength. Once the sealing process is completed, check for possible leaks and shorts. If the sensor fails your inspection, simply make another one. It will only cost you pennies.

The construction of the optional wetness sensor SEN2 is identical to SEN1, except that SEN2 is not sealed in a plastic bag—it is left exposed so it can detect water on contact.

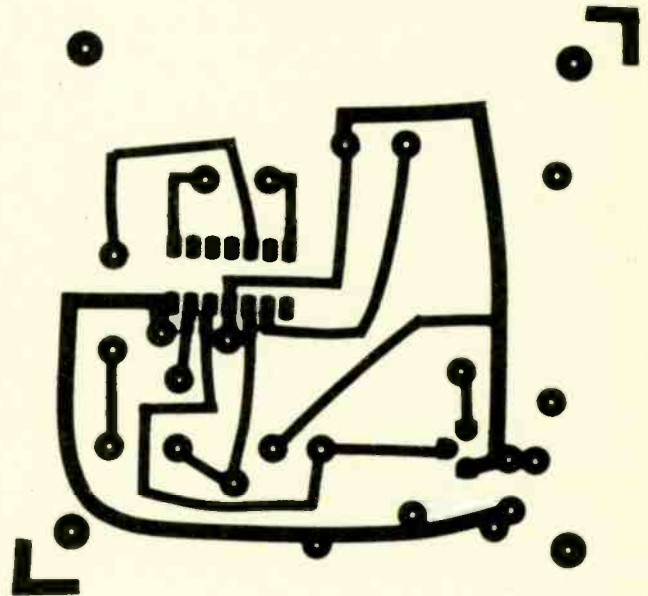


Fig. 4—Shown here is the printed-circuit board foil pattern used in the construction of the Aquisense prototype.

### Circuit Board Construction

The assembly of the circuit itself is simple and any method of construction is satisfactory. For those who wish to use a printed-circuit board, Fig. 4 shows the author's foil pattern.

Figure 5 shows the parts-placement diagram for Aquisense's printed-circuit board. Notice from Fig. 1 and Fig. 5, that if you do not use external reference resistor (R2), C1 is connected between pin 10 and pin 13 of U1.

Capacitors C4 and C5—whose purpose is to increase stability—are optional. In most cases there is sufficient stability even if they are omitted. The exact type of transistor for Q1 is unimportant. Just about any general-purpose NPN transistor works. The buzzer BZ1 should be of the low-power, solid-state type, rated somewhere between 5 and 10 volts. The recommended power source for the project is 4 C- or D- cell batteries connected in series. (Continued on page 103)



# HI-TECH TELEPHONES



Today's telephones are a far cry from Dixie cups and string. They have features to inspire the imagination of any high-tech enthusiast.

By Jeff Holtzman

**H**ENRY FORD'S MODEL T WAS ORIGINALLY SOLD IN ANY color you liked, as long as it was black. And it wasn't many years ago when telephones were sold in the same manner. There were two styles (desk and princess), and they came in a limited variety of drab colors. But even before Ma Bell was split into a number of Baby Bells, an insightful judge decided it was time we were allowed to connect our own devices—telephones, modems, fax machines—to the phone lines. And that decision drastically altered the telephone industry.

Today, choosing a phone can be traumatic, simply because of the number of options available, the way they're combined in phones at different prices, and the sheer number of phones themselves. In this article we'll discuss those features, why they may be important to you, and how they're combined in various real-world phones. Then you'll be able to decide which features you need, based on the amount of money you've got to spend.

## A Phone is More Than a Phone

Probably the feature that attracts most people away from a basic Model-T type phone is one-button dialing, which allows you to program a single button to dial a long series of digits. That way, when you get an uncontrollable midnight urge for a Mucky-Slop Pizza, you can dial the Mucky-Slop Pizza Shop instantly and alleviate your craving. (You can also set up a "hot-line" to the publisher for complaining about weird magazine articles.) The key features to consider are the number of memories, and the number of digits each will store.

In today's market, one-button dialing is ho-hum. To be really "with it," you need more features. Such as? How about a HOLD BUTTON, so that when Mucky-Slop asks how you're going to pay, you don't have to let them hear you argue with your roommates about who paid last time?

Yeah, hold is nice. But what else is new? How about last-number re-dial, so that when Mucky-Slop's line is busy, you can re-dial quickly? How about demon-dialing (which goes by several names, including breakthrough dialing), in which the phone will re-dial a number for you repeatedly until it breaks through a number that's always (or so it seems) busy? Getting better, huh?

## There's More

Other features to consider are extra buttons that can be useful in dialing out of an office. A Pause button inserts a pause (usually of a few seconds duration) into a sequence of digits that are being stored in a memory. A Flash key breaks your line connection for a very short period of time (about half a second), thereby simulating pressing the cradle switches (used to gain an outside line in some systems). Before buying an office phone, however, make sure your phone is compatible with your office's phone system.

Some phones can function as an intercom. For example, many cordless phones can now communicate with the base station as an intercom. And some standard models can communicate with similar models when both are connected in parallel to the same phone line. And speakerphone capability can be useful in a number of situations.

At least one phone (Radio Shack's DuoFone-146) has a feature, that when enabled, causes the phone to dial a number automatically whenever the phone goes off-hook (i.e., whenever someone lifts the receiver from the cradle). That could be useful for baby sitters, older relatives, etc.

Of course, there's always the question of style. There are large buttons, small buttons, lighted buttons, square buttons,



Sharp's TP-220 (upper) features elegant styling, three memories and last-number redial. The TP-320 (lower) features a 20-number memory, speakerphone, and more.

round buttons, angled buttons—and that's not to mention handset and base styles (see the accompanying photos for examples). Phones today are available in everything from office-tan to grey, black, burgundy, and mauve, as well as pastel blue, pink, and lavender, not to mention (in the words of one press announcement from Sharp) "sweet ice-cream colors." If it's style you're after, you should be able to get it—just shop around.



**Panasonic's KX-T3142 is a two-line phone with 20 memories and speakerphone capability. It's features are representative of the latest high-tech phones.**



**Panasonic's KX-F115 combines a full-featured dual-line phone, answering machine, and fax (which can also function as a page copier). Imagine having one in your office.**

### **A Phone is an Answering Machine?**

Returning to functionality, after dialing features, integration of a telephone and an answering machine is high on many wish lists. Amazing advances have been made in that area the last few years. About eight years ago, I bought a plain answering machine for more than what an integrated unit sells for today. The old unit was large enough to set a standard desk phone on, and it weighed a ton. Now a complete unit is barely larger than the phone alone.

A big factor determining overall size is the type of storage used for both the incoming message (ICM) and the outgoing message (OGM). The least expensive but bulkiest machines use a standard cassette tape for each function. Other ma-



**Sharp's FP-M62 is the first tapeless answering machine. Solid-state memory devices record both the outgoing message and as much as 80 seconds of incoming messages.**

chines use a microcassette for both; yet others record the OGM in solid-state memory, and record ICMs on tape. There's even one machine (Sharp's FP-M62) that records both the OGM and the ICM's in solid-state memory. However, it's limited to five sixteen-second messages or ten eight-second messages.

Some answering machines can be set up to work with one, two, or both lines in a dual-line setting. Some can record conversations, a handy feature for doing interviews and undercover-spy work (just kidding). If that ability is important to you, beware that some machines can only record for a pre-set amount of time (thirty seconds or three minutes, for example). A related feature, called "memo recording," allows you to record a message for your secretary or family using the machine's built-in microphone, rather than requiring you to call from a remote location.

### **Answering Plus**

Fancy features on the more-expensive units include the ability to record a computer-synthesized message stating when each ICM arrived. And a call counter is nice to let you know how many calls were recorded while you were out. Some machines simply light an LED to indicate that at least one message has been received.

Most modern answering machines include a remote control that allows you to retrieve messages, rewind the tape and record over old messages, etc. However, use of some remotes requires a good memory or a crib sheet if you don't use it very often. The reason is that a single tone activates all functions, so depending on when and how many times you press the button, different things happen. Other answering machines activate different functions by the DTMF tones generated by push button phones. You can also activate those functions with a portable tone generator.

What happens if the tape fills up while you're away? Some machines just beep at subsequent callers and hang up. Others may be set to rewind the tape and record over previous messages.

Some machines have a budgeting function called, among other things, Toll Saver, that can save you money when retrieving messages by remote control. With Toll Saver activated, the machine will not answer the phone on the first ring (as it does normally) if no messages are pending. That allows you to hang up and avoid incurring a long-distance charge.

Other more-specialized functions include the ability to





Sharp's CL-300 is a stylish cordless phone that can also function as an intercom. The base unit can function as a speakerphone, and a regular telephone can be plugged into it for normal conversations when the hand unit is elsewhere.



Panasonic's RC-TX91 combines a full-featured, memory-dialing phone with an answering machine and an AM/FM clock radio. All of its functions are digitally controlled.

forward messages to a specific number at a specific time, and the ability to record a "memo" locally and have it "delivered" to a specific number at a specific time—all without any action on your part.

### A Phone is a Clock Radio?

The most feature-laden consumer phones now include a full-function clock radio with AM/FM reception, digital clock, alarm, snooze timer, etc. If you're interested in that type of phone, make sure that it automatically disables the radio when you lift the receiver or dial a number on-hook. Otherwise, the calling party might be treated to a little concerto of music and feedback.

Some clock-radio phones (and others as well) include hot keys labeled POLICE, FIRE, DOCTOR, EMERGENCY, etc., that dial the appropriate number when pressed.

### A Phone is a Business Tool?

For business use, costs escalate quickly, but so do features. Radio Shack used to sell an integrated phone/300-baud modem, but removed it from the 1988 catalog. You may still be able to find one in an "as-is" sale.

Panasonic sells a highly popular integrated phone/answering machine/facsimile machine (Model KX-F115) that does high-speed (Group III) fax transmission, can function as a page copier, and that also contains speed dialing, hold, pause, and many other features. At a cost of several thousand dollars, you'll have to break into your piggybank for this one.

Another Panasonic model, the KX-D4985 InfoCenter, combines a phone with what amounts to a rudimentary personal computer containing a 300/1200 baud modem, a 25 × 80 line CRT, a serial port, a disk drive, and a keyboard. Special software helps time management, phone directory, phone logging, etc. The phone unit has two-line operation (with conference calling), tone and pulse dialing, demon dialing, speakerphone, and more. The system appears to be designed for telemarketers who spend much time on the phone scheduling appointments, taking orders, etc.



Radio Shack's DuoFone 146 features a 32-number memory, demon dialing, a call timer, and a hot-line dialer. When using the hotline dialer a stored number is dialed automatically whenever the receiver is lifted.

Other specialized devices exist to help the small-business user. An automatic call-forwarding device (Radio Shack's DuoFone CFS-200, for example) forwards calls received on one to line to a pre-programmed number on another line. Obviously, you must have two lines to use the device.

An accounting monitor (such as Radio Shack's DuoFone CPA-1000) plugs in anywhere on your line, and monitors all out-going calls. The device contains a built-in printer that prints the starting time and date of each call, as well as its length. You can associate an account number with each telephone number, and thereby bill clients for time spent on the phone in their behalf.

An electronic "baby sitter" is also sold by Radio Shack (the DuoFone Sensor Alert) that monitors temperature, electrical conditions, and room noise. If any condition becomes



Panasonic's KX-T2622 (top) combines a stylish speakerphone with an answering machine; the latter has a call counter. The KX-T2620 (bottom) is similar, but has no call counter.



Radio Shack's TAD-312 is an inexpensive but high-quality dual-cassette answering machine with full remote capabilities.

TABLE 1—FEATURES CHART FOR MODERN TELEPHONES AND ANSWERING MACHINES

Feature	PANASONIC		SHARP		TANDY	
	KX-T2622	RC-TX91	FP-M62	CL-300	DUOFONE-146	TAD-312
Type	C	C	C	P	P	A
Cordless	N	N	N	Y	N	N/A
Radio	N	Y	N	N	N	N/A
Clock	N	Y	N	N	Y	N/A
Timer	N	Y	N	N	Y	N/A
Intercom	N	N	N	Y	N	N/A
Number of lines	1	1	1	1	1	1
Conference calling	N	N	N	N	N	N/A
Speakerphone	Y	Y	N	Y	N	N/A
Speaker mute	Y	Y	Y	N	N	N/A
Ringer vol cntrl	Y	Y	N	Y	Y	N/A
Call Screening	Y	Y	N	N	Y	N/A
Redial	Y	Y	Y	Y	Y	N/A
Save redial	N	N	N	N	Y	N/A
Breakthrough dialing	Y	N	Y	N	Y	N/A
On-hook dialing	Y	Y	Y	N	Y	N/A
Tone dialing	Y	Y	Y	Y	Y	N/A
Pulse dialing	Y	Y	Y	Y	Y	N/A
Number of memories	16	16	25	20	32	N/A
Memory size (digits)	30	30	16	16	16	N/A
Hot keys	0	3	0	0	1	N/A
Hold key	Y	Y	Y	Y	N	N/A
Flash key	Y	Y	N	Y	Y	N/A
Pause key	Y	Y	Y	N	Y	N/A
OGM (tape/IC)	IC	TAPE	IC	N/A	N/A	TAPE
ICM (tape/IC)	TAPE	TAPE	IC	N/A	N/A	TAPE
Answer msg. transfer	Y	Y	Y	N/A	N/A	N
Remote control	Y	Y	Y	N/A	N/A	Y
Two-way recording	Y	Y	Y	N/A	N/A	Y
Ring Selector	Y	Y	Y	N/A	N/A	Y
VOX/limit recording	BOTH	BOTH	LIMIT	N/A	N/A	Y
Wall mount	Y	N	Y	N	Y	N
Desk mount	Y	Y	N	Y	Y	Y
Line/AC powered	AC	AC	AC	AC	AC	AC
Battery backup	Y	Y	Y	Y	Y	N/A
Max call count	99	16	1	N/A	N/A	1
Warranty (months)	12	24	N/A	N/A	12	12

suspect, the device will call as many as four pre-programmed numbers, and with a computer-synthesized voice, inform the answering party what the problem is. By calling the device, you can reconfigure it, as well as listen to what's going on in its immediate area.

**Comparison Chart**

Table 1 compares the features of several popular telephones, answering machines, and combinations thereof, made by several manufacturers. The models chosen were selected not because we particularly recommend them, but because most of the features you'll want to consider are represented by one or more models. The following explain the meaning of potentially unclear items in the table:

Type specifies phone (P), answering machine (A), or combination of the two (C).

Speaker Mute allows you, in speakerphone mode, to prevent the caller from hearing what's going on in the room.

Call Screening allows you to listen to the caller and interrupt the answering machine should you wish to take a call.

Redial allows you to redial the last number dialed by pressing one key; Save Redial allows you to save that number in a special memory.

Breakthrough dialing keeps redialing a telephone number until the phone breaks through a busy line.

On-hook dialing allows you to dial a number (either manually or automatically) without lifting the receiver.

Hot Keys are similar to one-button dialing keys, but are pre-labeled FIRE, POLICE, etc.

The next group deals with answering machine functions. OGM and ICM (tape/IC) specifies whether the out-going and in-coming messages are stored on tape or in the unit's solid-state memory.

Answer message transfer allows a phone to transfer a received message to another number.

Two-way recording in some machines is limited to the normal message length.

Ring selector specifies the amount of time after ringing commences when the the phone should be answered.

VOX/limit recording specifies whether message recording should cease after a specified period of time or after the caller stops speaking.

**A Phone is also a Phone**

As we've seen, a phone by any other name might not smell as sweet, but it sure might be an answering machine, a clock radio, a modem, a FAX, a PC, or some combination. Whether you're interested in a more efficient way to order pizza or to conduct business, there's surely a new telephone for you.





## Ungar Rechargeable Soldering Gun Kit



**What do you do when you're on the roof soldering bulky antenna connections and need power without a power cord? Reach for the Ungar 1200**

**C** LIMBING A LADDER TO MAKE A soldering connection on outdoor PA speaker terminals is no big thing provided that there are no obstacles. My problem was that I was at a neighbor's country house without my tool box, the nearest power outlet was over 50-feet away, no extension cords were available, and all I had was my friend's 25-watt soldering iron. By the time I yanked the iron's power cord from the outlet, ran across the back yard and up the ladder, the soldering iron did not have enough heat to properly solder the output leads to the speaker terminals. To solve the loss of poolside music for that weekend, I used alligator-clip leads to make the connections rather than remove the bulky speaker and mounting bracket. The following weekend I returned, took a soldering gun from my car trunk, immediately climbed the ladder (which was not taken away) and properly soldered the two terminals. I did this with the aid of my newly acquired *Ungar 1200 Rechargeable Soldering Gun*.

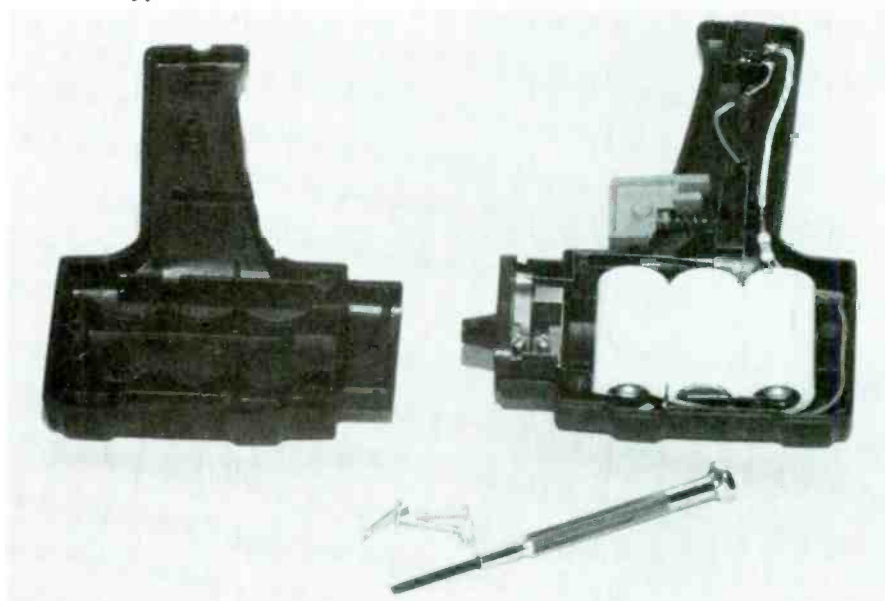
### What Is It?

The Ungar new 1200 Rechargeable Soldering Gun is a battery-operated device that offers extended power periods,

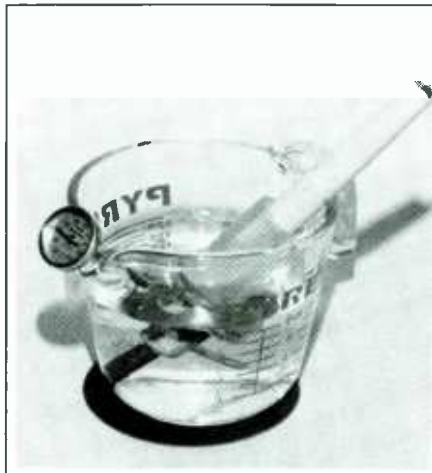
portability, and maneuverable performance untethered from a power-line cord. Called the Ungar 1200 Rechargeable, the gun is suited for all types of quick soldering jobs and for use in areas where power is not readily available. Typical uses include solder-

ing tasks in hard-to-reach areas or where power is not readily available, and the servicing of electronic and electrical systems on boats, aircraft, or other vehicles.

State-of-the-art NiCd (nickel-cadmium) batteries deliver a combined rat-



Here's something you normally shouldn't do to hand-held tools—take them apart. The Ungar 1200 Rechargeable Gun comes apart by the removal of four screws. Three series-connected NiCd batteries are present with a rectifying diode in the handle. Should servicing be required, it can be user repaired. For information circle No. 83 on the Free Information Card in this magazine.



The photos show the BTU heat output test. It is a comparative test and places the soldering gun at a disadvantage. Nevertheless, the soldering iron tip raises the temperature ever so slightly, whereas the Ungar 1200 Rechargeable Gun is one magnitude higher. The real test for the gun occurs when the need for a solder connection must be made quite some distance from an AC outlet.



ing twice as powerful as previously-offered portable soldering devices, whose use has been limited largely to fine-electronics repairs.

The Ungar 1200 Rechargeable is equipped with a general-purpose soldering tip suited to most electrical repairs, kits, and radios. The tip heats up rapidly to provide as many as 250 solder joints between battery charges using a 20-watt tip. Optional accessories for the soldering gun include a fine tip for electronics applications and a 60-watt heavy-duty tip for heavy electrical work and metal repair.

The unit also features: a UL-listed wall-plug charging unit which provides overnight recharging of the gun; a trigger safety lock to prevent accidental



Ungar supplies a plastic carrying case so you can tote the gun to the job. The white plastic foam can be removed so you can store and carry other related tools.

turn-on; and a trigger-activated light which illuminates the work piece just like the big AC-operated guns.

### Testing the Gun

Beside the obvious field test that inspired this product's report, the Ungar 1200 Rechargeable was "lab" tested! The first test compared the gun to a 20-watt soldering iron. The iron was heated to full heat allowing time for the tip to reach maximum heat. It was then used to make soldering connections to a terminal strip. Quick action permitted three successful solder joints (after some practice) before the iron's tip got too cold to melt solder properly. The Ungar 1200 Rechargeable soldered 45 joints successfully before the user ran out of connections to solder.

The next test compared the BTU heat output of the soldering iron and the Ungar 1200 Rechargeable. A measured amount of water (one cup) was chilled

to 50 °F with ice cubes, the cubes were then removed and the preheated 20-watt soldering tip (including the inseparable heating element) was dropped into the water. The temperature rose 2 °F. The same volume of water was chilled to 50 °F and the soldering tip of the gun was immersed. A rubberband held the power trigger-switch closed. The temperature rose to 72 °F before the bulb became too dim for normal soldering usage. The BTU heat test was ended.

The test indicated that used *continuously*, the Ungar 1200 Rechargeable gun could make eleven times more soldering connection than a heated soldering-iron tip after it was unplugged. Admittedly, no one would operate a gun by continuously holding down the trigger—this is a wasteful approach. The batteries have a tendency to heat up and reduce the device's overall power-delivery efficiency. After a ten-minute wait there was enough soup in the batteries to make additional soldering connections.

These test and subsequent practical shop and field usage of the Ungar 1200 Rechargeable indicated that the gun was a viable product fulfilling the claims of its maker.

### Tips and Other Things

The Ungar 1200 Rechargeable comes with a 1201 standard, 20-watt plug-in replaceable tip that is suitable for electrical repairs, kits, and radios. Should you purchase the 2200 kit, the 1202 heavy-duty, 60-watt plug-in replaceable tip is supplied as an extra tip, and it can be used for heavy electrical, stained glass, metal repair, and other high-wattage applications. With more heat, more power is used and the battery will deliver approximately one-third the useful time before recharging is re-

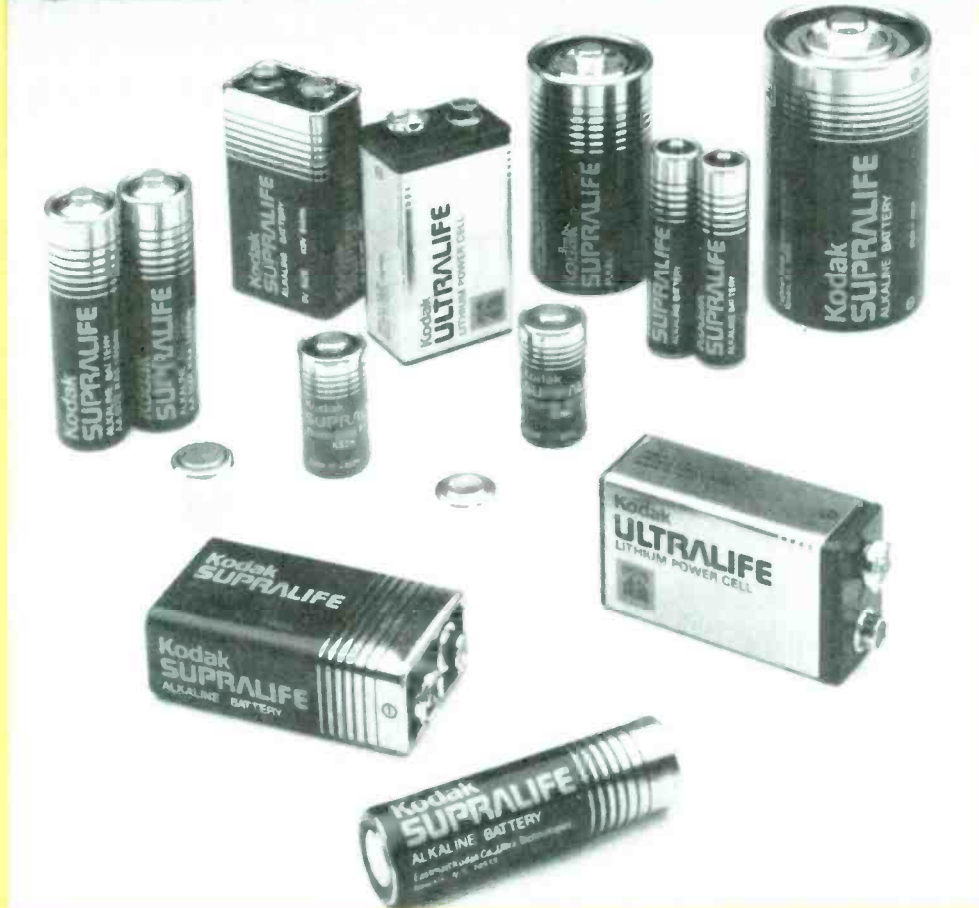
(Continued on page 106)



The business end of the Ungar Rechargeable with the 20-watt and 60-watt soldering tips side by side. The tip slips into the gun-handle plastic frame and two screws (not shown) secure the tip and make firm electrical contact.



# BUILD A 12-VOLT BVM



## A simple monitor circuit for your battery-powered whatsits

By James A. Gupton, Jr.

**T**he warm summer months have finally arrived, and your weekend plans involve nothing more strenuous than sunning yourself at the local beach. You grab that powerful boom-box radio (powered by 14 D-cell batteries), your favorite tune blaring through 6-inch woofers. Finding a secluded area of the beach, you lay claim to your "bag of sand"—stretching out your blanket and setting up temporary housekeeping.

You lay there, the music soothing your jangled nerves when suddenly, *silence*. It never seems to fail; just when you need them most, batteries have a bad habit of letting you down—that's true of all batteries, be they zinc, alkaline, or NiCad. That fact, in itself, points out the need for some means by which to determine battery status (under normal equipment load), without having to go into the battery compartment armed with your trusty voltmeter. And what else would you call such a device, but a *Battery-Voltage Monitor (BVM)*—for that is exactly what it does.

### Schematically Speaking

Shown in Fig. 1 is the schematic diagram for a 12-volt BVM. The circuit is built around the LM3914 bar/dot display driver—a chip normally associated with power-level meters for stereo systems, and other applications where constant

level monitoring is desirable or advantageous. Capable of indicating battery-operating voltage in 1.3 volt steps with 10 colored LED's, the circuit is simple enough to be assembled on perfboard (using point-to-point wiring), pre-etched experimenters board, or printed-circuit board.

The BVM's extremely-low parts count (potentially small size) is adaptable for internal mounting. Or if you prefer, it can be mounted outboard to the equipment case. Two construction methods are given (printed-circuit board and perfboard) to enable the beginner or experienced hobbyist to build the BVM using readily available components.

It is not necessary to use all 10 LEDs; as few as 2 LEDs may be used to indicate voltages of 9.1 and 10.4 volts (1.3 volt increments); 4 LEDs to indicate 9.1 to 13.0 volts; or all 10 LEDs to indicate 9.1 to 22.1 volts. The LEDs connect to pins 1 (9.1 volts) and increments from pin 18 to 10 in 1.3 volt steps (with pin 10 indicating 22.1 volts).

Pin 10 can be set to turn on at any voltage by adjusting the 100,000-ohm potentiometer to turn on an LED at the desired voltage level, and will automatically maintain the 1.3-volt increments with the LEDs in the downward steps to 9.1 volts.

Figure 1 shows two 1N4739 (9.1-volt) Zener diodes; one in parallel with a 100-microfarad, 35-volt capacitor, and the

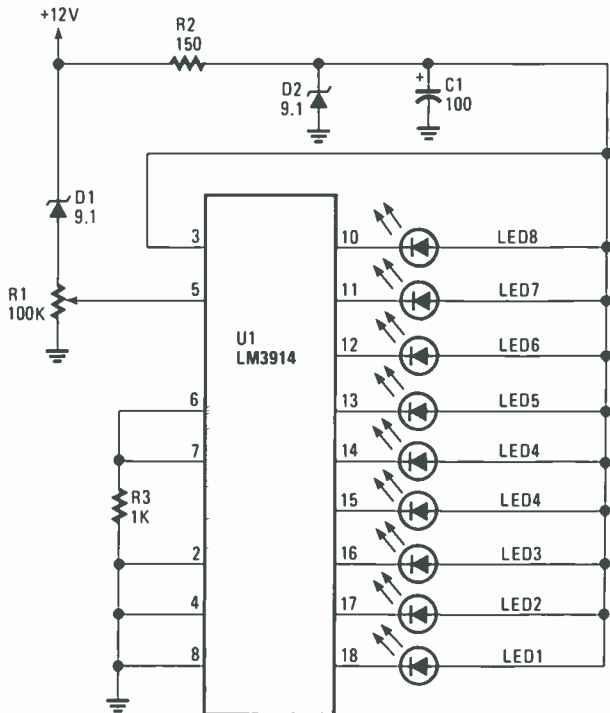


Fig. 1—Shown here is the schematic diagram for a 12-volt BVM. The circuit, built around the LM3914 bar/dot display driver, is capable of indicating battery-operating voltage in 1.3-volt steps. The BVMs extremely-low parts count (potentially small size) is adaptable for internal mounting, and lends itself to almost any construction technique, including perfboard using point-to-point wiring.

other in series with the 100,000-ohm potentiometer. In the case where adjustment of the potentiometer is too critical to preset the desired voltage at pin 10 precisely, replace the Zener (connected to the potentiometer) with a 1N4738, which is rated at 8.2 volts.

## Construction

The author's prototype of the 12-volt BVM, which was assembled on a 1.35" by 2.25" piece of perfboard, is shown in the photo. The circuit can be laid out as shown, and hard-wired connections used to complete the signal and power paths. It's recommended when doing point-to-point wiring that a color-coded wiring scheme be used—*black* insulated wires for ground paths, *red* for +V, and *white* for component connections. However, a much easier way is to use the printed-circuit layout for the BVM provided in Fig. 2.

### PARTS LIST FOR THE BVM

- C1—100-μF, 35-WVDC (radial) electrolytic capacitor
  - D1—1N4739 9.1-volt Zener diode
  - D2—1N4738 8.4-volt Zener diode
  - LED1, LED10—Jumbo red light-emitting diode
  - LED2-LED7—Jumbo yellow light-emitting diode
  - LED8, LED9—Jumbo green light-emitting diode
  - R1—150-ohm, 1/4-watt, 5% resistor
  - R2—1000-ohm, 1/4-watt, 5% resistor
  - R3—100,000-ohm vertical-mount PC potentiometer
  - U1—LM3914 Bar/Dot display driver, integrated circuit
- Printed-circuit or perfboard, etchant and etching tray, wire, solder, hardware, etc.

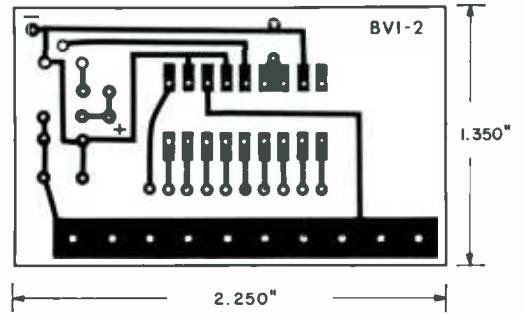


Fig. 2—Although the author's prototype of the 12-volt BVM was assembled on a 1.35" by 2.25" piece of perfboard, a printed-circuit pattern is shown here for those who prefer printed-circuit construction.

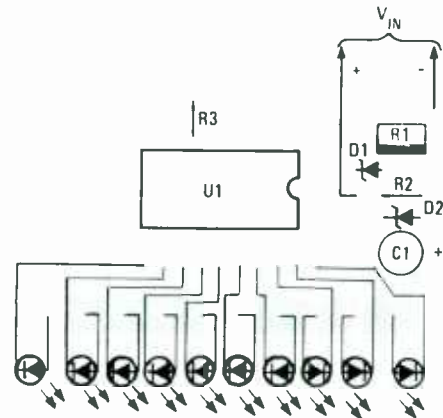


Fig. 3—After preparing the PC board from the pattern provided in Fig. 2, populate it according to this parts-placement guide. In the author's prototype, 6 LEDs were used: one *green* LED to denote full charge; three *yellow* to denote minimum-functional operating range; and a *red* unit to denote the recharge point.

duced to the outside dimensions given, will position the LM3914 pin holes exactly 0.1" apart corresponding to the spacing between the IC's pins. The pattern may be photocopied to produce a negative image for photosensitive reproduction of the PC board. Or it may be used to pin-punch hole locations, and the pattern copied onto some clean PC-board stock with an resist-ink pen. After which, the board can be subjected to ferric-chloride etchant.

After etching, all holes should be drilled with a #60 drill bit, with the exception of the 3 holes for the 100,000-ohm potentiometer—drill them with a #55 bit. Once the etching and drilling is complete, populate the PC board using Fig. 3 as a guide. The 1000-ohm resistor, located between pins 8, 6, and 7 should be mounted vertically or have both leads bend under the resistor body and formed to fit the hole spacing provided on the board.

In the author's prototype BVM, 6 LEDs were used: one *green* LED to denote full charge; three *yellow* to denote minimum-functional operating range; and a *red* unit to denote recharge point. A second small *red* LED also was placed above the *green* LED to denote 9.1 volts as a warning to recharge before using the battery pack.

## Installation

In operation, the battery monitor draws a minimum of 10 to 20 milliamperes, which will not adversely affect normal battery operating current. However, the positive power

(Continued on page 102)





# A POWER LINE FOR TIN LIZZY

Have 120-volts AC available  
whenever you hit the road

By Sam Allen

If you've ever wished you had a 120-volt AC outlet in your car, van or camper, this just may be the project you should build. The device's cord plugs into an automotive cigarette-lighter receptacle and converts the battery's 12-volts DC to 120-volts AC. This type of device is traditionally called an inverter, we will make no exception here.

The inverter is capable of powering a variety of 120-volts AC devices drawing up to 40 watts. Since the voltage of an automobile electrical system can vary considerably depending on the battery condition and whether the engine is on or off, the inverter also gives you the option of selecting a high or low AC output.

Before you begin construction, it is important that you understand the limitations of the inverter. Any electrical device that uses a shaded-pole motor won't operate on the power provided by this inverter. Any electrical or electronic device that requires a stable frequency won't work either. That apparently severe limitation still leaves a lot of gadgets and devices that will work.

## What Can it Do?

You can use it to power old tube-type gear that you would like to use in a mobile application. I have operated a small tube-type guitar amplifier with the inverter. Some tube type-gear will exceed the unit's 40-watt limitation, so check the specification plate that is usually riveted to the chassis rear apron. It may seem like the inverter won't handle the load when you first turn on a tube-type device; but the current draw will go down after the tubes warm up, so let it run awhile. When using the inverter with audio equipment you may notice more hum than usual; it depends on how effective the pulsating DC filtering circuit in the device is at coping with the frequency and waveform of the inverter.

## Solid Operation

You can also power-solid state equipment with this inverter. If the equipment is sensitive to line noise, you may need to plug in a *power-conditioner* between the inverter and the equipment. I have operated a Radio Shack Color Computer without any problem. I use the inverter to power the computer only; I have a 12-volt DC television receiver to use as a monitor and I operate a battery operated cassette-tape recorder for data storage. (That may sound like a Mickey

Mouse hookup to you, but I've been portable when the lap portables were still on the drawing boards in Tokyo.)

I have also powered a satellite TV receiver with the inverter, but it did produce some on-screen interference. Various radios and stereo components can also be used in a mobile application if they don't exceed 40 watts.

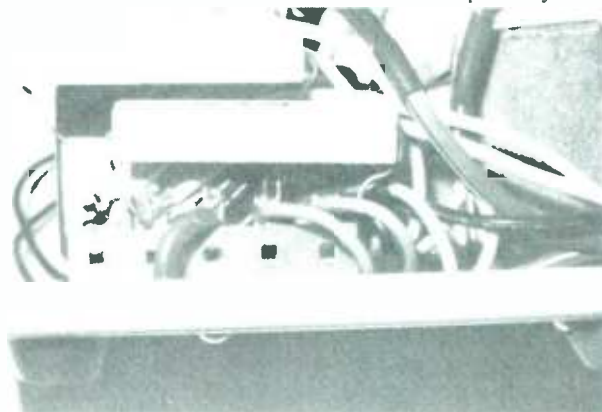
You can use the inverter to run a soldering iron when you're out in the boon docks and need to solder something. It will also operate a hair-curling iron or hot curlers for a hairdo on the go. (Tell that to your wife and you'll have to start construction today!)

The inverter is useful in many applications, so even if you don't want to build this particular inverter, you may find this circuit handy in some other project when you need to increase a DC voltage.

## Theory

A power step-up transformer can be used to increase an AC voltage, but how do you increase a DC voltage?

A transformer will only induce a current in the secondary winding when the magnetic flux is changing. When AC is applied to the primary winding, the flux is constantly changing in response to the changing voltage. If DC is applied to the primary of a transformer, a current will be induced in the secondary as the flux builds up; but it will stop when the magnetic flux reaches its maximum and then remains constant. When the DC is disconnected from the primary, the



A five-lug tie point is used to mount resistors R1 and R2 and provide suitable tie points for soldering the connections.

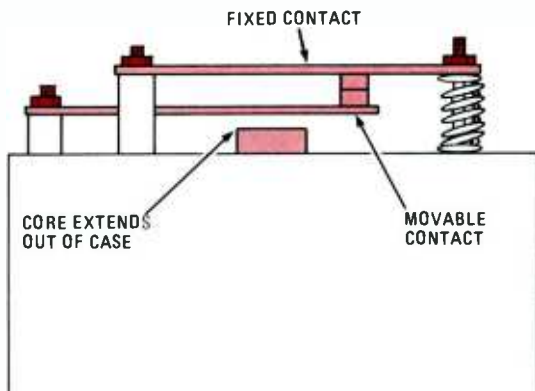


Fig. 1—The Model T Ford used a vibrating contact to make and break the primary winding circuit of the ignition coil.

flux will rapidly collapse inducing another short burst of current in the secondary. So a simple way to operate a transformer on DC is to use a pulsating DC current.

The old Ford Model "T" ignition coil used that principle to provide high-voltage energy for the spark plugs. (See Fig. 1.) The primary-winding current passed through a set of breaker points. One point was fixed and the other is attached to a piece of spring steel. The points were placed directly over the iron core of the transformer. When the magnetic flux was sufficiently strong, the spring-steel mounted contact was attracted to the core and the points opened, breaking the circuit. When the flux collapses, the spring closed the points starting the cycle over again.

In order to achieve a good AC output from a pulsed-DC input, the voltage must reverse every half cycle. That can be achieved by using a center-tapped primary. By applying a current to one half of the coil and then the other half, the output will alternate.

### The Vibrator

That can be done through mechanical means using the same principle as the Ford Model "T" coil. In that case the device is called a vibrator. Refer to Fig 2. Electrical vibrators were commonly used in mobile-radio power supplies during the vacuum-tube era. Vibrators saw their last mass-applications in the 1950's.

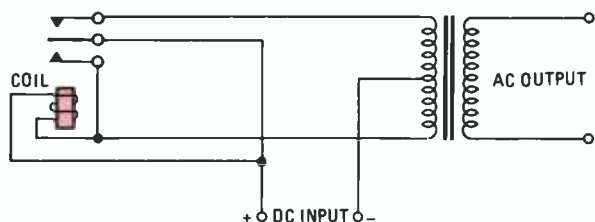
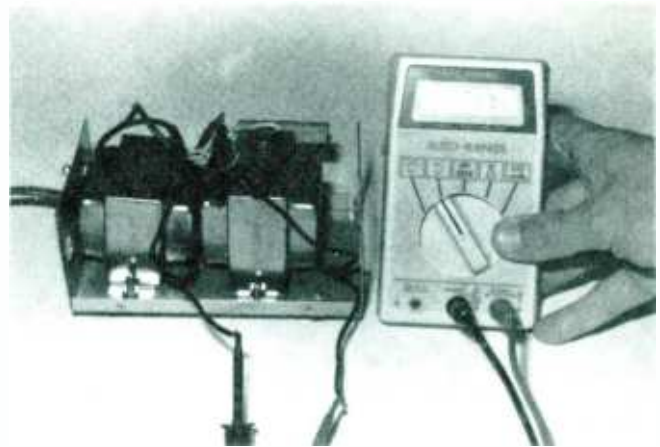


Fig. 2—During the vacuum-tube era, mobile radios used a vibrator to apply current alternately to each half of the center tapped primary. This is called "chopping."

A vibrator contains a set of points on a spring-steel reed and a small electromagnet coil. When the circuit is off, the reed is positioned between the two contacts touching neither. When the circuit is powered (turned on), the coil pulls the reed over to one set of contacts (the lower contacts in Fig. 2) directing current through one half of the primary winding; in the process the coil winding is shorted out of the circuit de-energizing the coil. That action releases the reed and allows it to spring over to the contact connected to the other half of the primary winding. The coil is energized



Before permanently connecting the secondary windings to the electrical outlet, check for proper voltage-phase relationship. When connected properly, a voltmeter should read about 40 volts. Be sure to observe the same safety precautions you would take when working on any live 120-volt AC power circuit.

again, but before the coil can pull the reed back again, current flows in the other half of the primary winding. As the reed again travels to the lower contact and the cycle starts over. Observe that the current flow through the primary winding of the transformer in Fig. 2 first flows in one direction, and then the other.

### Using Transistors

Figure 3 illustrates a push-pull power oscillator. The circuit performs essentially the same function as a electrical vibrator. When current is applied to the circuit, one of the transistors will start conducting faster than the other. It doesn't matter which one starts first. Positive feedback through a resistor fires the second transistor and that action results in the first transistor in shutting down. It's obvious that current will flip-flop through the primary winding of the transformer as the two transistors alternate firing periods. It is a simple circuit, so let's go to the circuit in Fig. 4 for the moment.

As before, one of the transistors in Fig. 4 will fire first. The current through the primary winding will induce a small voltage in the extra secondary winding included in this special type of transformer. That winding is connected to the bases of the transistors with its polarity arranged so that the induced voltage biases the conducting transistor to conduct more, and the other transistor is biased to cutoff. As the conducting transistor allows more current to flow through the primary, the biasing voltage increases so the magnetic flux of the transformer continues to build up until it reaches its maximum. At that point there is no change in the flux so there is no induced voltage in the biasing winding causing

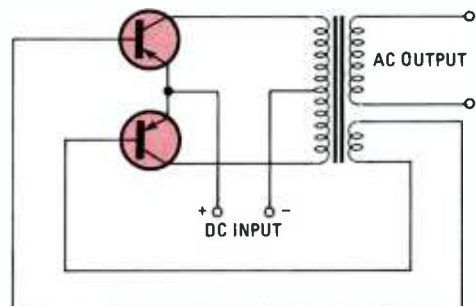
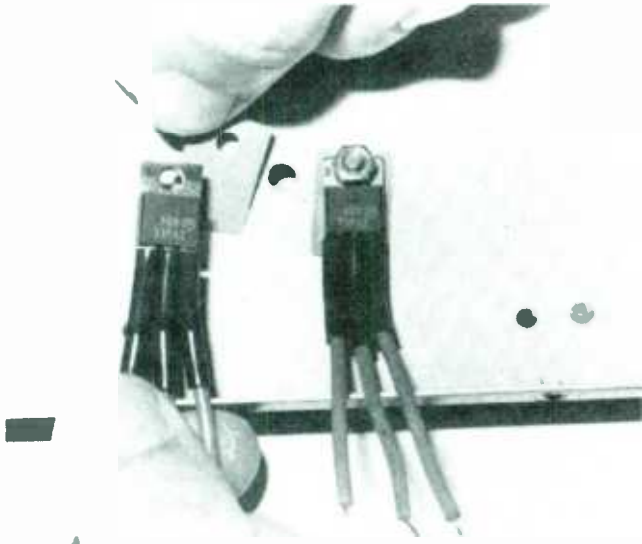


Fig. 3—This transistor push-pull oscillator performs the same function as the vibrator. The base terminals of the transistors are biased by using an added secondary winding.





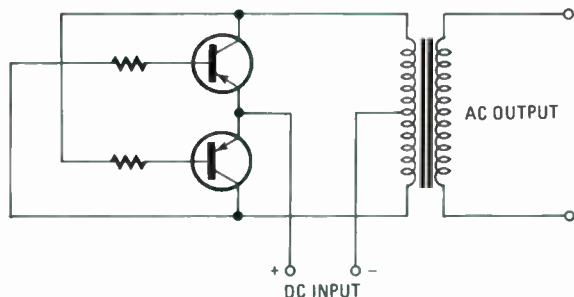
**Mount the transistors to the bottom of the case. Use insulating hardware to electrically isolate them from the case. Notice that wire leads have been soldered to the transistors and the connections insulated with heat shrink tubing.**

the collector current of the conducting transistor to decrease. That in turn causes the magnetic flux to collapse. As it collapses, a voltage with an opposite polarity is induced in the biasing winding. That voltage biases the conducting transistor to cutoff and the other transistor to conduct.

### A Better Way

The problem with the circuit in Fig. 3 is that it requires a special type of transformer. Special-type transformer means difficulty in availability and high price. The circuit in Fig. 4 can be used with any center-tapped transformer. (You may have one in the junk box.) Instead of requiring a separate secondary winding, the bases of the transistors are connected to the collector of the opposite transistor through a resistor.

When the switch is closed, one of the transistors begins to conduct. Because the bases are connected to the collectors of the opposite transistors, when one begins to conduct the opposite transistor is biased to cutoff and the conducting transistor is biased to conduct more. When there is no further change in the current flowing through the primary winding, its reactance drops to zero, causing the collector voltage to decrease. That biases the opposite transistor to conduct which in turn biases the previously conducting transistor to cutoff. The cycle continues, directing current alternately through one half of the primary then the other. The frequency of oscillation can be adjusted by changing the value of R1 and



**Fig. 4—In this circuit the base-biasing voltage is taken from the collector of the opposite transistor through the resistors. This eliminated the need for a special type of transformer.**

R2. The simplicity of this circuit makes it appealing for many applications; however, it does have some drawbacks. The output is not a true sine wave and the frequency tends to change with load.

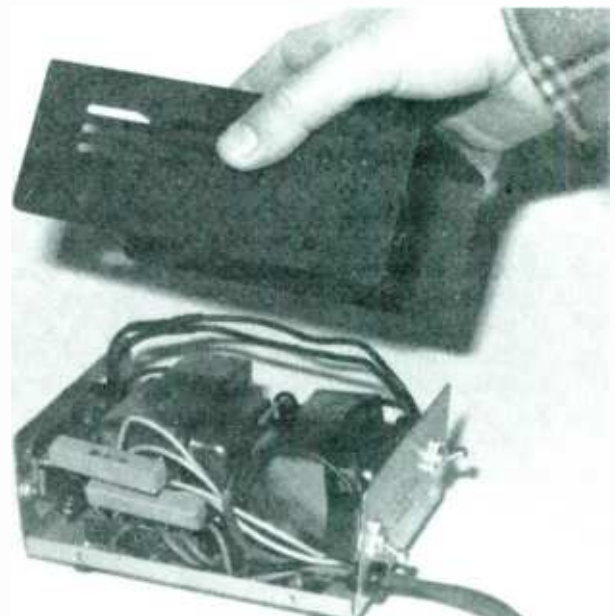
If a stable frequency and a sine wave output are required, then it is better to use an oscillator to generate a stable sine wave at a low amplitude and then amplify it to drive the transformer. That can lead to a fairly complex circuit, so it is usually only done when it is really required.

### Getting Started

Start construction of the inverter by preparing the metal case. The case specified in the Parts List is about the smallest that will hold all of the parts. It makes a nice compact package that will easily fit in a glove compartment. If you want a more open parts layout you can use a larger case. Beginners are urged to use a slightly larger case. Cut a rectangular hole for the duplex outlet in the back of the case. One way is to drill an entrance hole at one corner and then use a fine-toothed coping saw to complete the opening. A nibbler tool can also be used.

Solder 6-in., 18-gauge wire leads to the transistors and insulate the connections with heat-shrink tubing. Drill mounting holes for the transistors on the bottom of the case between the two transformers. The case will act as a heat sink for the transistors. Use insulating washers to keep the transistors electrically isolated from the case. Refer to the photos. Use insulating bushings on the screws to isolate them and the case from the transistors; if you don't, the exposed screw heads may short against a metal part of the vehicle.

To make it easy to find the parts, two step-down transformers are used. They are connected in reverse to be used as step-up transformers. In that instance the low-voltage winding becomes the primary winding and the high-voltage winding is the secondary winding. In order to compensate for variations in input voltage, two different transformers are used. An 18-volt transformer gives a higher output voltage for use when the input is low and a 25-volt transformer gives a lower output voltage for times when the charging system is putting out a higher input voltage. When the 40-



**A view of the completed inverter. All that is left is to close the case and install the outlet cover. Now test it!**

watt switch is closed the two transformers are connected, doubling the available amperage and averaging out the voltage to a value between the high and the low.

## Connecting

Mount the transformers in the case and install a five-lug tie-point strip on one of the transformer-mounting screws. To connect the components, refer to the schematic (Fig. 5) and the tie-point numbering diagram (Fig. 6).

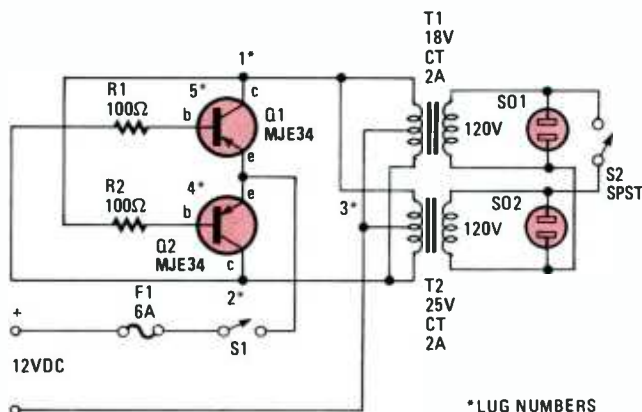


Fig. 5—12-volt DC to 120-volt AC inverter schematic diagram is not much more difficult to read and understand than the circuit-theory examples provided in Figures 2, 3 and 4.

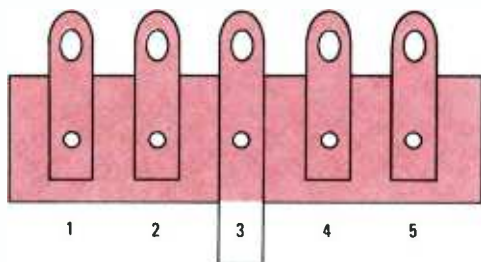


Fig. 6—Five-lug tie point-lug numbers refer to schematic diagram and in the text descriptions related to the photos.

Install the power cord through a grommet in the front panel. Solder the positive lead to a fuse holder. A 6-A. fuse is used to protect the circuit. An in-line fuse holder can be tucked between the transformers. If you used a larger case you could use a panel-mounted fuse holder. Connect the other lead from the fuse holder to one terminal of the power switch S1.

Attach the emitter lead from both transistors to the other terminal of S1. The negative-power lead and the center-tap leads from the primaries of both transformers are soldered to the center lug (#3) of the tie point strip. That lug grounds the negative lead to the case. Attach the following leads to the lugs, but don't solder until the resistors are installed. One lead from both transformer primaries is attached to lug #1. The collector lead from Q1 is also attached to lug #1. Connect the remaining two primary leads and the collector lead from Q2 to lug #2. The base of Q2 is connected to lug #4. Connect the base of Q1 to lug #5.

## Resistor Selection

Resistors R1 and R2 control the frequency of the AC and affect the over-all efficiency. I experimented with values from 50 to 680 ohms. For my purposes 100 ohms was best, but you may want to try another value. The resistors really

## PARTS LIST FOR THE 12-VOLT DC TO 120-VOLT AC INVERTER

- F1—Fuse, 6-A and in-line holder
- SO1, SO2—Duplex electrical outlet—15-A, 25-volts AC
- Q1, Q2—MJE34 PNP power transistor (Radio Shack 276-2027 or equivalent)
- R1, R2—100-ohm, 10-watt resistor
- S1, S2—SPST toggle switch
- T1—Step-down transformer: 120-volts AC primary; 18-volt 2-A, center-tapped secondary (Radio Shack 273-1515)
- T2—Step-down transformer: 120-volts AC primary; 25-volt, 2-A, center-tapped secondary (Radio Shack 273-1512)
- Five-lug tie point (Radio Shack 247-688), metal case (Radio Shack 270-252, or larger), transistor-mounting hardware, cigarette-lighter cord and/or clip leads, hookup wire, solder, hardware, decals, etc.

only need to be rated at 2 watts, but the 10-watt type is more readily available. Connect R1 to lugs #2 and #5. Resistor R2 goes between lugs #1 and #4. No more connections need to be made to the tie points so you can solder all of the joints.

## Final Steps

The secondary windings of the transformers must be connected in the proper phase relationship. When the circuit is ready to operate but before installing the outlet, take one lead from each secondary and twist them together. Connect an AC voltmeter to the other two leads. Set the meter on the 500- or 1000-volt range. Remember that you will be dealing with the equivalent of house current so use the same precautions. Connect the power cord to a 12-volt battery and switch on the inverter. If everything is operating correctly, you will hear a buzz and there will be a voltage reading on the meter. If the reading is around 40 volts the secondaries are connected correctly. If the voltage is much higher, around 240 volts, then turn off the inverter, disconnect the wires that are twisted together and reconnect one of the leads that was connected to the meter to the lead from the other transformer.

The electrical outlet is a standard 15-A, 120-volt duplex type. It will have a set of silver-colored screws on one side and a set of brass-colored screws on the other. The two screws on each side are connected with a removable link. Use a pair of needlenose pliers to break off the connecting link between the two brass-colored screws. Attach the two transformer leads that are twisted together to the silver-colored screws. Connect the other two transformer leads to the brass screws. Also attach the two leads from the 20/40 watt selector switch to the two brass screws. You're now ready to close up the case and install the outlet cover.

## Testing and Use

As an initial test, connect the power cord to a 12-volt battery and plug a neon night-light into the inverter outlet. When you switch on the unit, both electrodes in the neon bulb should glow with equal brilliance. Next use a 15-watt light bulb as the load. Check the output voltage at each outlet with the 20/40 watt switch in both positions. With the vehicle engine off, the 20/40 watt switch set on 20 watts and a 15-watt load plugged into the high outlet, the voltage will be about 125 volts. With the same load plugged into the low

(Continued on page 98)



# LOW and HIGH PASS FILTERS

By Louis E. Frenzel

**Not every signal coming down the pike is welcome in your circuits. If you know the secrets of filter design you can get rid of any unwanted intruder.**

**F**ILTERS ARE FREQUENCY-SENSITIVE CIRCUITS THAT ARE used to pass signals in a specific frequency range, but reject signals outside that range. There are four common filter types: low pass, high pass, band pass and band reject. Their names tell exactly what they do. Such filters are used in almost all kinds of electronic equipment. They are so common, in fact, that they are usually taken for granted despite the important part they play. Filters are, in many cases, "invisible" circuits because, while the components are visible, they are often mistaken for something else or simply overlooked.

In this article, I want to introduce you to low- and high-pass filters and the math you can use to analyze and design them. It's pretty straightforward and it will give you a real appreciation for the subtlety of those circuits.

## Low-Pass Filters

A low-pass filter allows signals with frequencies lower than a designated cut-off frequency to pass, but will highly attenuate signals above the cut-off frequency. Figure 1 shows the response curve of an ideal low-pass filter. This curve is a plot of the output voltage ( $V_O$ ) vs. frequency. Note the sharp drop-off in output at the cut-off frequency ( $f_{CO}$ ). Frequencies above that point are effectively eliminated.

It is not possible to make a low-pass filter with such ideal

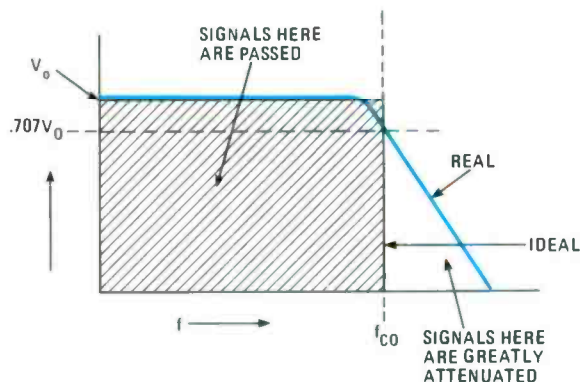


Fig. 1—This frequency response curve is for a low-pass filter. It shows how the output of the filter drops dramatically after the cut-off frequency.

characteristics. Practical filters do not have such rapid or abrupt attenuation at the cut-off. Instead, the attenuation increases gradually with frequency. Figure 1 also shows the response curve of a real low-pass filter. The cut-off point is that frequency where the output voltage drops to 70.7% of the output voltage ( $.707V_O$ ) at zero frequency (DC). Beyond the cut-off frequency, the attenuation increases linearly.

## RC and RL Low Pass Filters

Figure 2 shows two ways to implement a low-pass filter. The RC filter is more common because capacitors are usually smaller, less expensive, and available in a wider range of values than inductors. In either case, both circuits act as frequency-sensitive voltage dividers.

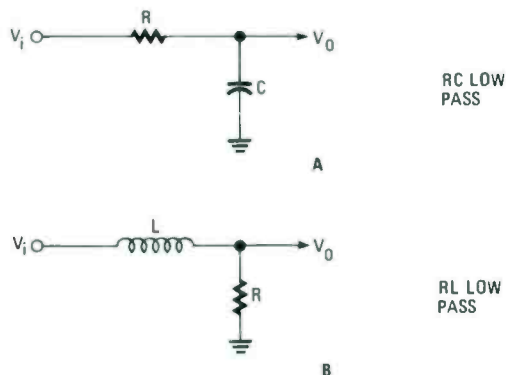


Fig. 2—Although these filters (the RC in A and the RL in B) use different components, they are both low-pass designs.

In the RC filter, the capacitive reactance ( $X_C$ ) is very high compared to the resistance at frequencies below the cut-off. Therefore, most of the input voltage ( $V_i$ ) appears across the capacitor and becomes the output. Little voltage is lost or dropped across the resistor. But as the frequency goes up,  $X_C$  goes down. Therefore, less voltage appears at the output and more is dropped across the resistor. The effect is more pronounced as the frequency increases.

In the RL filter, a similar thing occurs. At frequencies below cut-off, the inductive reactance ( $X_L$ ) is very low compared to the resistance, so little or no voltage is dropped across it. Most of the input voltage appears across the output

resistor. When the frequency increases,  $X_L$  increases so the input voltage redistributes itself so there is more across the inductor and less across the output. And that trend continues as the frequency continues to increase. Because both the RC and RL filters are voltage dividers, they greatly attenuate the input signal especially if the frequency is above the cut-off.

**Attenuation**

For RC and RL low-pass filters, the attenuation rate is 6 dB per octave above the cut-off frequency. An octave is a two-to-one relationship between two frequencies. For example, there is one octave between 1500 Hz and 3000 Hz. Or, there is one octave between 800 Hz and 400 Hz. For each doubling of the frequency, the attenuation or loss increases by 6 dB. We say that the output voltage “rolls off” at a rate of 6 dB/octave.

If you recall, the decibel (dB) is a way of expressing large amounts of gain or loss in an electronic circuit. In filters, we use decibels to express loss or attenuation. Decibels are computed with the simple formula:

$$dB = 20\text{Log}(V_1/V_2)$$

Voltage  $V_1$  is the output voltage at some frequency above the cut-off while  $V_2$  is the output voltage at zero Hz or DC. The Log, of course, refers to the base 10 logarithm of the voltage ratio.

Assume that the output voltage at DC ( $V_2$ ) is 1 volt. The output voltage at the cut-off frequency is down 70.7% or  $1 \times 0.707$ . The dB value then is:

$$dB = 20\text{log}(.707/1)$$

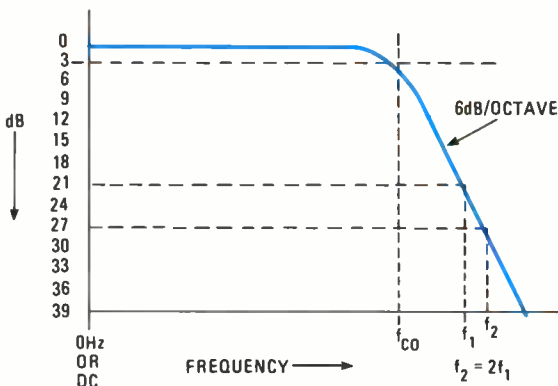
$$dB = 20(-.15) = -3 \text{ dB}$$

You get the Log by keying in .707, then pressing LOG on your calculator. The negative sign indicates that the logarithm of a number less than 1 is minus. That indicates a loss or attenuation.

So you can see that at the cut-off frequency, the attenuation is 3 dB. That’s why the cut-off is usually referred to as the 3dB-down point. Beyond the cut-off, the attenuation increases at 6 dB/octave.

**Graphing Attenuation**

Figure 3 shows a typical attenuation curve. Frequency  $f_1$  is some point above cut-off. The attenuation at this point is 21 dB. Frequency  $f_2$  is one octave above  $f_1$ , therefore,  $f_2 = 2f_1$ . At  $f_2$ , the attenuation is 27 dB. You can see that from  $f_1$  to  $f_2$ , the attenuation increases or the output decreases by  $27-21 = 6$  dB.



**Fig. 3—The cut-off frequency of a circuit is not the place where roll off begins, but is the place where the signal has dropped or rolled off by 3dB. This filter drops 6db/octave.**

The frequency scale in Figure 3 is linear, that is, each frequency division or increment is equal to the others. Linear scales are easy to understand and work with, but when a very-wide frequency range is used, such scales become extremely large. Often, the scale is too big to fit on a standard size piece of paper. In such cases, a logarithmic or Log scale is used.

A Log scale is shown in Figure 4. Note how the divisions on the horizontal scale are not equal. They are large on the left but get smaller on the right. The divisions vary logarithmically. Then the pattern repeats. Each repeat of the pattern represents one decade or a ratio of 1-to-10. With this arrangement, you can see how a very wide frequency range can be represented in a very small space.

Now look at Figure 4 more closely. That is the response curve of a low-pass filter with a cut-off of 900 Hz. Note that the output is down 3 dB at 900 Hz. Beyond 900 Hz, the attenuation is 6 dB per octave. One octave from 900 Hz is 1800 Hz at 1800 Hz, the output is down 6 more dB to 9 dB. In one decade between 1800 and 3600 Hz, the output drops 6 dB more to 15 dB.

Attenuation is also expressed in dB/decade where a decade is a 1-to-10 or 10-to-1 frequency ratio. A single section RC or RL filter has an attenuation rate of 20 dB/decade. This rate is identical to 6 dB/octave. Note in Figure 4 that from 1 kHz to 10 kHz, the output drops from 3.8 dB to 23.8 dB or 20 dB.

The vertical attenuation scale in Figure 4 is linear with equal increments of dB attenuation. Graph paper that has one Log scale and one linear scale is called semi-log paper. Graph paper with two Log scales called log-log paper is available. One scale is used for frequency and the other for a very-wide amplitude range.

**Cut-off Frequency**

Besides the attenuation rate, the key specification of a low-pass filter is the cut-off frequency where the output is down 0.707 or 3 dB. At this frequency in an RC filter, the resistance (R) equals the capacitive reactance ( $X_C$ ).

$$R = X_C = 1/6.28fC$$

Rearranging this expression with algebra to solve for f gives us the cut-off.

$$R = 1/6.28fC$$

$$6.28fRC = 1$$

$$f_{co} = 1/6.28RC$$

Using this formula, you can compute the cut-off if you know the resistor and capacitor values. For example, if  $R = 10K$  ohms and  $C = .05 \mu F$ , the cut-off is:

$$f_{co} = 1/6.28(10^4)(.05 \times 10^{-6})$$

$$f_{co} = 318.5 \text{ Hz}$$

**RC Low-Pass Design**

Designing a low-pass filter is also easy using this formula. Ordinarily, you begin the design by knowing what the cut-off frequency is. Let’s say it’s 3.5 kHz. For example, you may want all audio/voice frequencies up to 3.5 kHz to pass through an amplifier but you want to eliminate higher frequencies.

Next, you choose a value of resistor. Select a resistor that is at least ten times the internal impedance of the driving source ( $R_S$ ) as shown in Figure 5. Also choose R so that it is less than one-tenth the load resistance ( $R_L$ ). Assume  $R_S$  is 600 ohms and  $R_L$  is 100K ohms. So make R ten times higher or 6000



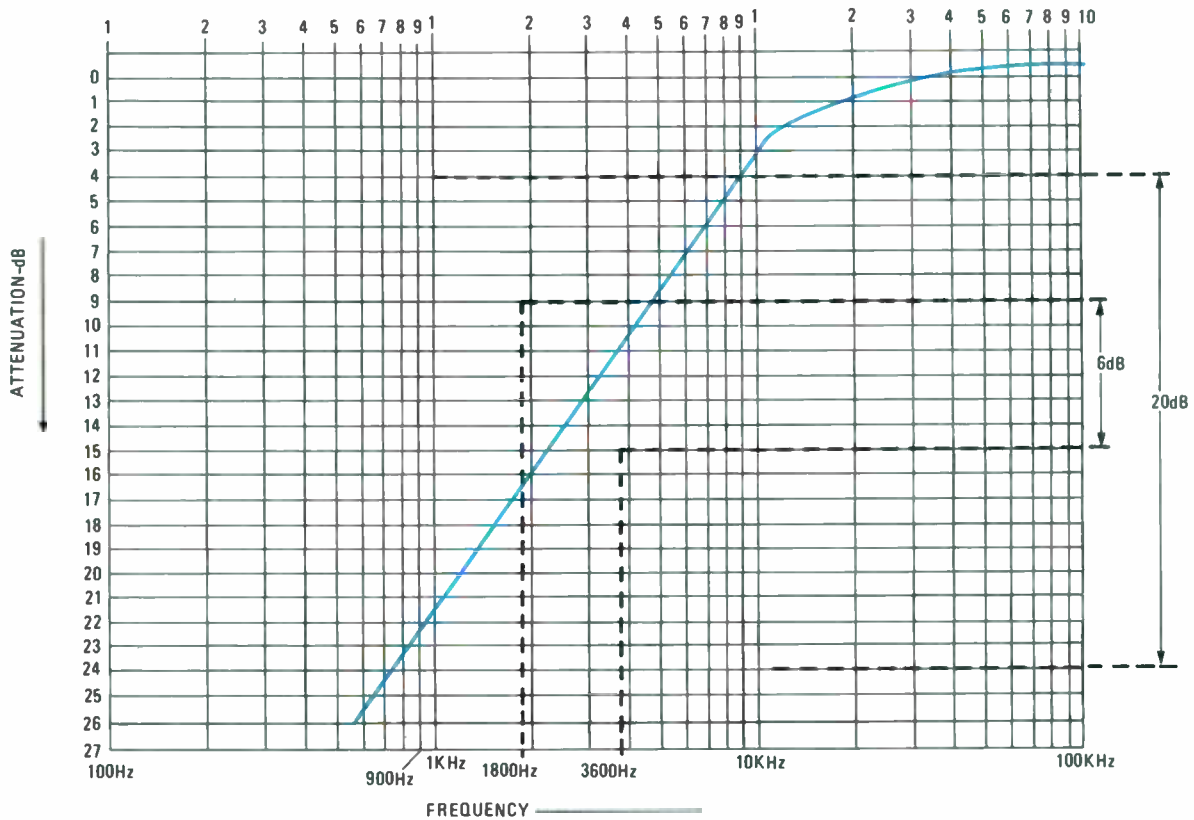


Fig. 4—Using semi-log graphs, it is easy to figure out the roll-off rate; here it's 6db/octave.

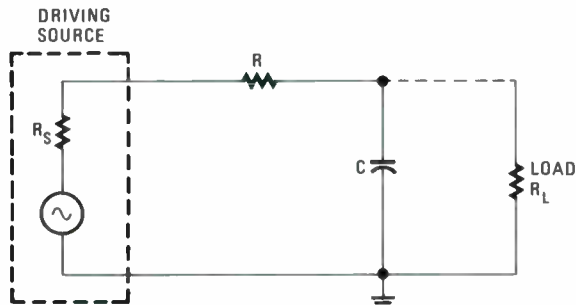


Fig. 5—Selecting a value for the filter resistor based on the source and load resistances is easy. The resistance should be about 10 times greater than the source's resistance, but 10 times less than the load resistance.

ohms. That is less than one-tenth of 100K or 10K, but R could be as high as 10K. You could choose a standard 6.8K ohm value. Now all you need to do is reshuffle the formula to solve for C:

$$C = 1/6.28fR$$

$$C = 1/6.28(3.5 \times 10^3)(6.8 \times 10^3)$$

$$C = .0067 \mu F$$

The closest standard value is .0068  $\mu F$  which would be close enough for most designs. If the value is too far from a standard value, you could combine standard values in series and/or parallel to get closer. You could also trade the 6.8K for another value and recalculate C to see if you get closer to a standard value of capacitance.

### The RL Operation

RL low-pass filters are similar in operation and design. At the low frequencies,  $X_L$  is very low so little of the input voltage is dropped across it. Most appears across the output resistor. As the frequency increases,  $X_L$  increases. More

voltage appears across the coil and less across the resistor. The voltage divider action causes increasing attenuation with frequency. As with the RC filter, the attenuation rate is 6 dB/octave or 20 dB/decade.

At the cut-off frequency:

$$R = X_L$$

Since

$$X_L = 6.28fL,$$

then:

$$R = 6.28fL$$

Rearranging to solve for f gives us the cut-off:

$$f = R/6.28L$$

Let's take an example. If R is 15K and L is 2 mH, the cut-off is:

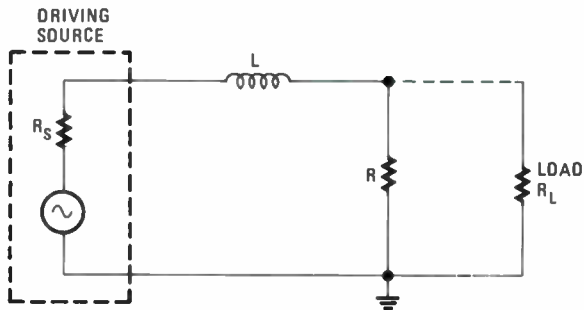
$$f = 15 \times 10^3 / 6.28(2 \times 10^{-3})$$

$$f = 1,194,267.5 \text{ Hz or about } 1.2 \text{ MHz}$$

The design procedure is somewhat similar. Pick a value of R at least ten times the source impedance, but less than one-tenth the load resistance. Then select the closest standard value. See Figure 6. Finally, solve for L. You may want to go back and choose a different R value so that the L value comes out close to one of the limited available standard values.

Let's design an RL low-pass filter that has a cut-off of 12 kHz. The source impedance is 100 ohms while the load is 50K ohms. We could make R ten times 100 or 1000 ohms and it would be less than one-tenth of 50K ohms. R could be as high as 5K. Let's select R as 2.2K ohms. Now to find the inductance, we rearrange the formula:

$$f_{co} = R/6.28L$$



**Fig. 6—**Figuring out the value for the filter resistor based on the source and load resistances is quick. The resistance should be about 10 times greater than the source resistance, but 10 times less than the load resistance.

to get:

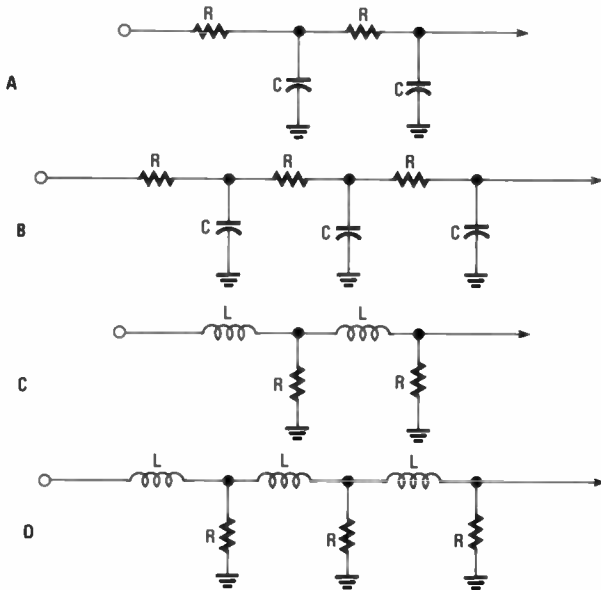
$$L = R/6.28f$$

$$L = 2.2 \times 10^3 / 6.28(12 \times 10^3)$$

$$L = .0292\text{H or } 29.2\text{mH}$$

A standard 30mH coil could be used.

One way to get a faster attenuation rate is to cascade RC or RL sections. Figure 7 shows two and three RC and RL sections cascaded. Each section produces 6 dB/octave so the two section filters give 12 dB/octave or 40 dB/decade attenuation while the three-section filter produces 18 dB/octave or 60

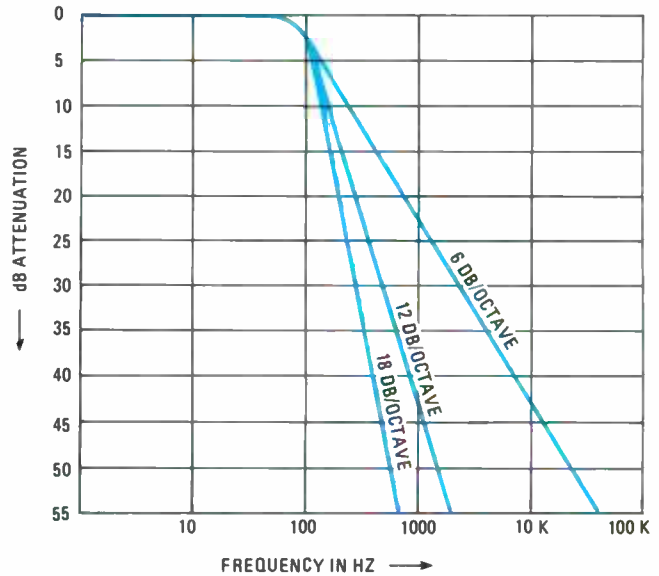


**Fig. 7—**If the roll off of a single section is not enough for a circuit, then the filters can be cascaded to provide greater attenuation. Unfortunately, that reduces the output.

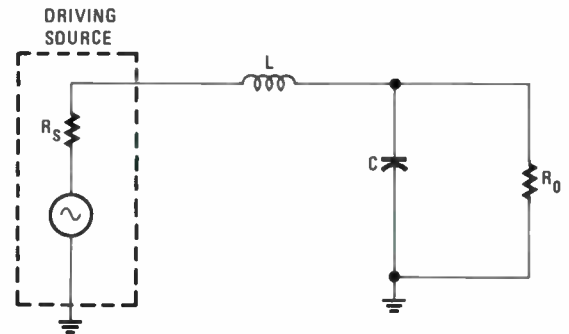
dB/decade. Such RL filters are rarely used, but the RC filters are very common. Figure 8 shows typical attenuation curves for one, two, and three section RC filters with a cut-off of 100 Hz. When sharper selectivity and more rapid attenuation are needed, multiple section filters do the job, but since each section is a voltage divider, the overall signal loss is very high. In some applications, amplifiers may have to be used before or after the filter to restore the signal level to a level high enough for the application.

### LC Low-Pass Filters

Another widely used low-pass filter is one that combines an



**Fig. 8—**The difference in roll-off between a single-section and a two-section filter is greater than the difference between a triple-section and a two-section filter.



**Fig. 9—**The advantage of an LC low pass is that it represents the same impedance to all frequencies.

inductor and a capacitor as shown in Fig. 9. It provides a faster attenuation rate than the basic RC or RL filter. It rolls off at 12 dB/octave or 40 dB per decade for each LC section. This is called a constant k filter. It is designed so that the impedance represented by the filter to the load remains constant with frequency. The formulas for computing R and C for a given cut-off frequency and source/load resistance are given below:

$$L = R_O / 6.28f_{co}$$

$$C = 1 / 6.28f_{co}R_O$$

The load or output impedance ( $R_O$ ) must be set up to match the internal impedance of the driving source  $R_S$  as shown in Figure 9. A value of 600 ohms is very common, but almost any value can be used depending upon the application.

### Designing an LC Low-Pass

Here's the calculations for designing a typical filter. Assume the impedance (R) is 600 ohms. Assume the desired cut-off frequency is 20 kHz.

$$L = R_O / 6.28f_{co} = 600 / 6.28(20 \times 10^3)$$

$$L = .00477 \text{ H or } 4.77 \text{ mH}$$

$$C = 1 / 6.28f_{co}R_O = 1 / 6.28(20 \times 10^3)(600)$$

$$C = .133 \mu\text{F}$$



The LC filter in Fig. 9 is called an L section. The same filtering effect can be achieved with two other configurations known as the T and pi filters shown in Figure 10. Note the adjustment in the L and C values for each configuration. As with RC filters, the L, T and pi sections can be cascaded to provide higher, more rapid attenuation.

### Usefulness

So what do you do with a low-pass filter? Lots. For example, it is a low-pass filter that removes the pulsating DC ripple from the output of a rectifier. A full wave rectifier used on a 60-Hz sinewave produces a 120-Hz ripple. A low-pass filter whose cut-off frequency is well below that value smoothes the ripple into nearly constant DC.

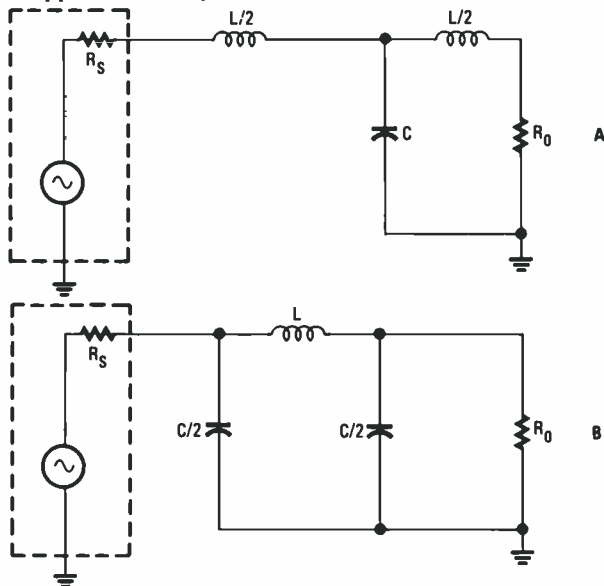


Fig. 10—Using a T (sometimes called a “tee” filter, which derives its name from the “T” shape formed by the capacitor and the inductors in A) allows you to increase roll off without resorting to cascading. The same is true of the pi filter without the problems of internal resistances and inductive couplings that can occur when using two inductors.

A low-pass filter is also used to restrict the upper frequency limits on the audio in an AM or FM transmitter to minimize the signal bandwidth. Or, a low-pass filter might be used to filter the unwanted harmonics out of a transmitter output.

Suppose you want to get rid of the harmonics at a CB or ham transmitter to prevent TV interference. Ham and CB signals are below 30 MHz and TV signals begin right above 50 MHz. Let's use 30 MHz as our cut-off.

We will put the filter into the coax antenna transmission line which normally has an impedance of 50 ohms.

Let's use a low pass like the one in Figure 10B.

$$L = 50/6.28(30 \times 10^6)$$

$$L = .27 \mu\text{H}$$

$$C = 1/6.28(30 \times 10^6)(50)$$

$$C = 10^6 \text{ pF}$$

The values of the capacitors in Figure 10B are C/2 or:

$$C/2 = 106/2 = 53 \text{ pF}$$

Standard values are 50 and 51 pF.

### High Pass Filters

A high-pass filter operates in a similar manner to the low pass only it passes signals above the cut-off and rejects or

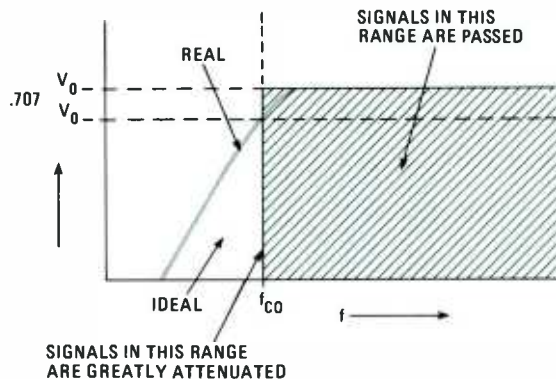


Fig. 11—A low-pass filter's response curve is a kind of mirror image to that of a high pass. That is because although the components are the same, you are allowing what was the unwanted portion of the signal in one to pass and sending the rest to ground. The high pass keeps the signals that the low pass would throw into ground.

greatly attenuates those below it. Figure 11 shows the basic ideal and real response curves for RC or RL high-pass filters. Above the cut-off frequency ( $f_{c0}$ ), the output is maximum and nearly flat. At the cut-off, the output voltage is down to .707 or  $-3 \text{ dB}$  in the real filter. As the frequency decreases, the output rolls off at a 6 dB/octave or 20 dB/decade rate.

Figure 12 shows the three basic high-pass configurations. As with the low pass, the RC version is the most widely used. The LC version is used where the faster 12 dB/octave roll off rate is needed.

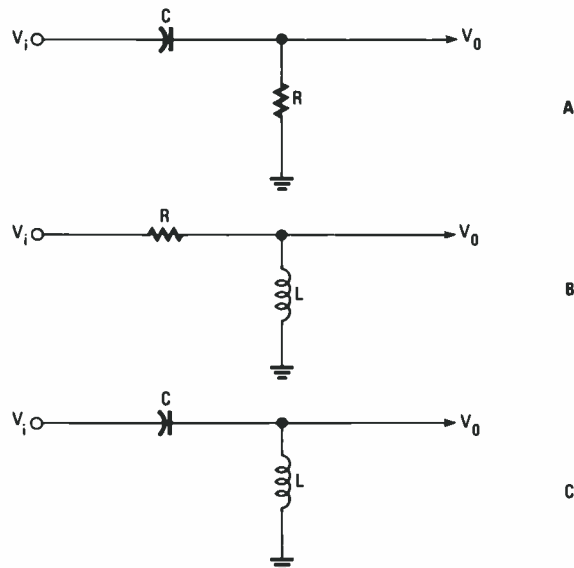


Fig. 12—The three basic high-pass filters, the RC in A, the RL in B, and the LC in C, are flopped around versions of their low-pass counterparts, and their equations are the same.

Like the low pass, the high pass is a voltage divider. In the RC circuit, the capacitive reactance is very low at the higher frequencies thus most of the input voltage appears across the resistor. As the input frequency increases, the reactance rises, causing more input to appear across the capacitor and less across the output resistor. Thus the output voltage rolls off at the lower frequencies.

### The High-Pass RL

In the RL high pass, the inductive reactance is very high compared to the resistor so at the high frequencies most of the

input voltage appears across the inductor. But as the input frequency drops,  $X_L$  drops so more of the input appears across the resistor and less across the inductor.

In the LC high pass, at high frequencies  $X_C$  is low and  $X_L$  is high and the input voltage divides accordingly. With a decreasing frequency,  $X_C$  increases and  $X_L$  decreases causing the 12 dB/octave roll off.

In the RC and RL filters, the cut-off occurs where:

$$R = X_C$$

or

$$R = X_L$$

That results in the cut-off frequency formulas we used earlier for the low pass.

$$RC: f_{co} = 1/6.28RC$$

$$RL: f_{co} = R/6.28L$$

Both the RC and RL filters produce exactly the same 6 dB/octave or 20 dB/decade roll off.

The design rules for RC and RL high-pass filters are the same as those for low-pass filters. Start by defining the cut-off frequency. Then select a resistor value that is at least ten times the internal source resistance  $R_S$  and less than one-tenth of the load resistance  $R_L$  as Figure 13 shows. Then using the appropriate formulas, calculate C or L.

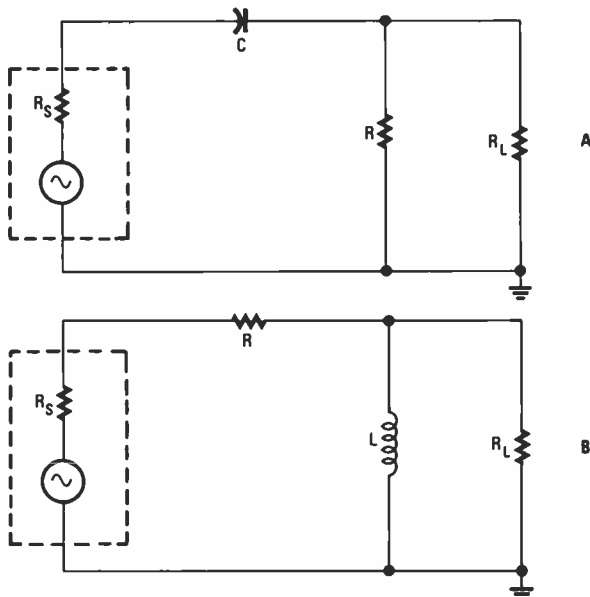


Fig. 13—The calculation for the resistance used in the high-pass filter of both the RC (A) and (RL) types is the same as it was for their low-pass counterparts.

### Design Examples

Assume a cut-off of 18 kHz, a source impedance of 1500 ohms, and a load impedance of 85K ohms. Resistor R should be at least 15K ohms. But it is more than one-tenth of 85K or 8.5K. In such a case, the source impedance may have to be lowered with an emitter- or source-follower or the load impedance increased with a follower as shown in Figure 14.

In an RC high pass, the load can be the circuit resistance. See Figure 13A. In the example above, the load is 85K ohms. It is much greater than  $R_S$  so just use  $R_L$  as R. With R at 85K ohms, we can now compute C.

$$C = 1/6.28fR$$

$$C = 1/6.28(18 \times 10^3)(85 \times 10^3)$$

$$C = 10^4 \text{ pF}$$

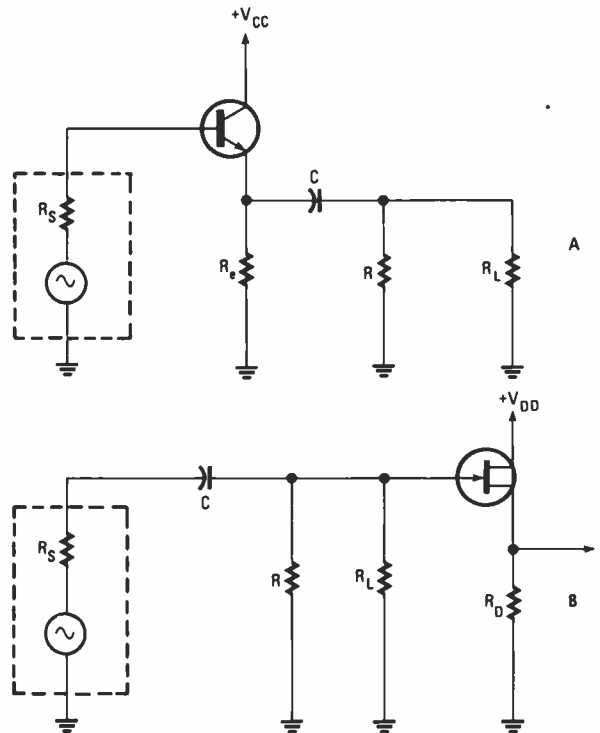


Fig. 14—When coupling amps together, it is important to know how much and what kind of attenuation the coupling components will place on the input signal.

Using the same design criteria as the RC filter, let's design an RL high pass. Assume we use a follower on the driving source to lower the source impedance  $R_S$  by a factor of ten to 150 ohms.  $R_L$  is still 85K ohms and:

$$f_{co} = 18 \text{ kHz}$$

Choose R equal to  $10R_S = 1500$  ohms.  $R_L$  is, of course, less than  $R_L/10$ . R could be as high as  $85K/10 = 8.5K$ . Let's use 1.5K. To compute L we use:

$$L = R/6.28f_{co}$$

$$L = 1500/6.28(18 \times 10^3)$$

$$L = .0133H \text{ or } 13.3mH$$

Higher attenuation rates can be obtained by cascading several RC or RL sections. It is rare to cascade RL filters, but RC sections are commonly cascaded as shown in Figure 15.

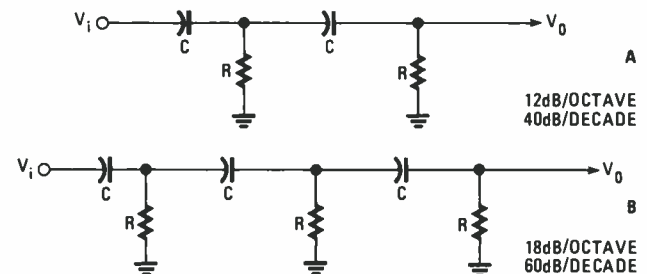


Fig. 15—Cascading RC high-pass filters provides faster roll-off by 6 dB per section. That means that the top most filter (the two section one) rolls off at 12 dB and the bottom (the three section filter) one rolls off at 18 dB.

The two-section filter rolls off at 12 dB/octave while the three-section filter rolls off at 18 dB per octave.



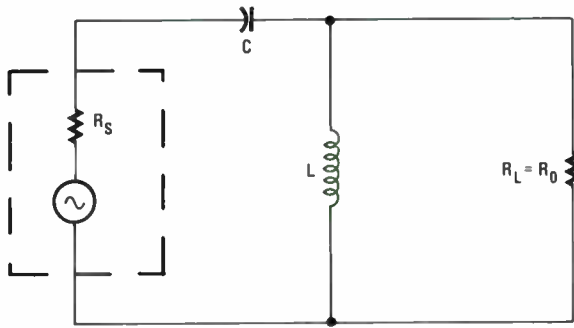


Fig. 16—You can make a constant-k high-pass filter by swapping the inductor and capacitor of a constant-k low pass. Even the calculations for the parts are the same.

### The LC High-Pass Filter

Faster roll-off can also be obtained by using an LC high-pass filter. The basic L-section is shown in Fig. 16. The LC constant-K high pass gives a roll off of 12 dB/octave or 40 dB/decade. The formulas for computing the L and C values are given below:

$$L = R_0 / 6.28 f_{co}$$

$$C = 1 / 2 f_{co} R_0$$

As with the low pass, those formulas are based on the use of matched source and load impedances. In Figure 16,  $R_L$  (or  $R_0$ ) must be equal to  $R_S$ .

Let's look at an example. Assume a generator and load impedance of 600 ohms. The desired cut-off frequency is 10 kHz. Therefore:

$$C = 1 / 6.28 (10 \times 10^3) (600)$$

$$C = .0027 \mu F$$

(This is a standard value.) And:

$$L = 600 / 6.28 (10 \times 10^3)$$

$$L = .96 \text{ mH}$$

(Use a 1 mH standard value.)

### T and L Types

High-pass filters can also be configured in T and L sections as shown in Figure 17. Notice how the L and C values are adjusted for these variations.

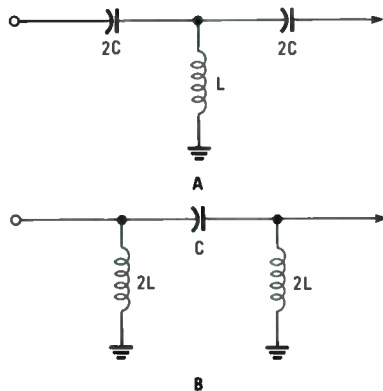


Fig. 17—Just as you can make T and pi low-pass constant-k filters, you can also make high-pass versions as in A and B respectively. They have the same advantages also.

In some applications where balanced lines or circuits are used, other configurations are used. Balanced means that both sides of the line or circuit are ungrounded. The two filter

leads are above and referenced to ground but not at ground. In such cases, filter components are put into both sides of the line. Figure 18 shows examples of high and low pass balanced constant k filters. An example of a balanced line is the 300-ohm twin-lead used on TV antennas.

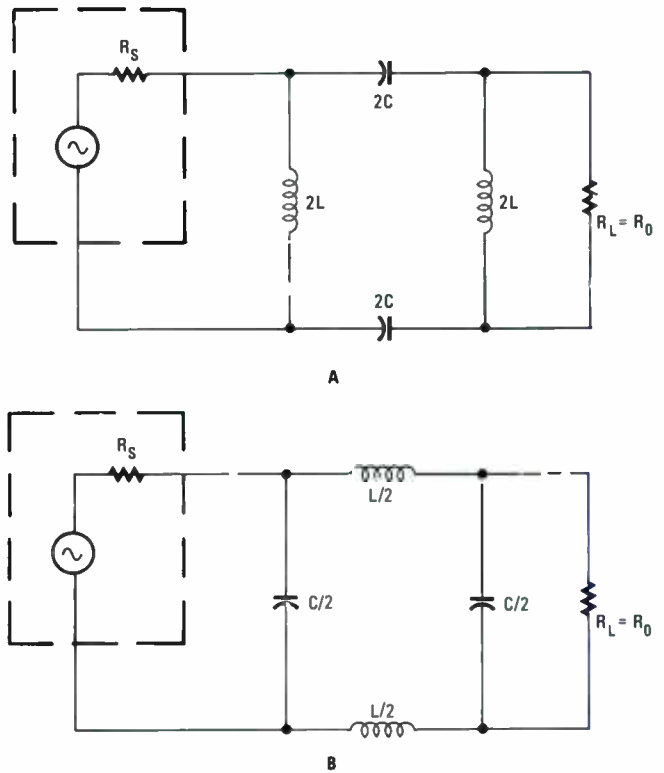


Fig. 18—Balanced high-pass (A) and low-pass filters (B) of this variety, have a constant impedance (constant-k).

Assume we want to design a high-pass filter like the one in Figure 18A to pass TV signals above channel 2, but filter out interference from CB and ham radio transmitters. Channel 2 transmits on about 54 MHz. So let's set our cut-off at 50 MHz. The impedance is 300 ohms. We use the standard formulas.

$$L = 300 / 6.28 (50 \times 10^6)$$

$$L = .96 \mu H$$

$$C = 1 / 6.28 (50 \times 10^6) (300)$$

$$C = 10.6 \text{ pF}$$

Now we have to modify the values as shown in Figure 18A. We simply multiply the values above by 2.

$$2C = 2(10.6) = 21.2 \text{ pF}$$

$$2L = 2(.96) = 1.92 \mu H$$

### Coupling Amplifiers

Perhaps the most common high-pass filter is the RC coupling network used between amplifier stages. Refer to Figure 19 for some examples. The capacitor connects the AC output of one stage to the input of another. The capacitor blocks DC so that each stage can be independently biased. The output or driving impedance in Figure 19A is the value of the collector resistor  $R_1$  of Q1. The input impedance of amplifier Q2 is the resistance value of  $R_3$ ,  $R_4$  and  $R_6 \times h_{fe}$  in parallel. The  $h_{fe}$  is the transistor gain or beta. The amplifier frequency response will be shaped by this RC combination.

(Continued on page 98)



# ELLIS ON ANTIQUE RADIO

## More From the Mailbag

□ SINCE WE DIDN'T GET ANYWHERE near the bottom of the mailbag last month, I thought we'd go right on this month with the comments and questions from you readers. It's about as interesting a batch of mail as I've seen in a in a long while, so let's dive right in and get to it.

### Vintage Shortwave

*Dick Ipsen* (Napa, CA) is into short-wave listening. And, as the nice photo he sent attests, his listening post includes a variety of vintage pieces. Sitting on top of his reel-to-reel tape deck is a Hallicrafters *5R-40* portable. To the right and slightly below it is a Hallicrafters *S-41G*—close relative of the Echophone *EC-1* that we restored in this column.

Under that is a mystery Hallicrafters bearing the designation *8R-40*; it seems to be a Hammarlund *HQ-100*. Dick has about 20 more collector's items not shown in the picture.

### For the Joiners in the Bunch

*Ronald Kapp* (Box 377, Campbelltown, PA 17010) is just getting started in antique-radio collecting and would like to learn about clubs, publications, etc., that will help him along in his new hobby. Practically in the same mail, I heard from *Michael S. Sabodish, Sr.* (11-A Matawan Ave., Cliffwood, New Jersey). Mike finds that belonging to clubs really enhances his hobby of collecting, restoring, and selling antique radios. He belongs to about ten different clubs.

Besides giving him an opportunity to share his interests, they serve as sources for hard-to-find parts. Send Mike a long SASE (self-addressed stamped envelope) and he'll send back information on the clubs. If you up the return postage to 44 cents, he'll also include information on antique-radio-related tie clasps and lapel pins that he has for sale.



Reader Dick Ipsen's listening post includes many interesting vintage sets.

### That Sinking Feeling!

It's happened to all restorers at one time or another. Understandably anxious to make every part of a vintage radio look as perfect as possible, we clean something a little too thoroughly and ruin it. As most of us with a little experience know, dial faces are particularly vulnerable.

*Peter McMillan* (4734 Zimmerman Ave., Niagara Falls, Ontario, Canada LZE 3M9) ruined the face on his Westinghouse *Model 675 BC/SW* set. The markings had evidently been done in water-based paint because they wiped right off the glass dial plate as he was washing it.

Peter wants to know if there's any way the dial can be restored (I don't know of any) and if the defaced dial will detract from the value of an otherwise perfectly restored piece (regrettably, yes). If the set were mine, I think I'd put it aside and wait for a similar model to turn up that I could use for parts.

Next time, Peter, try a "dry" cleaning tool (such as a soft brush) first. If

you must "wet" clean, avoid the use of detergents. Try a damp cloth first or, if that fails, add a little gentle soap—like Ivory. But be sure to test your cleaning technique on an inconspicuous area before going whole hog!

Perhaps one of our readers has a junker *Model 675* he would be willing to part with. If so, please contact Peter right away because, as he says in the close of his letter, he feels really bad!

### Solid-State Power For 01-A's

Noting that I used 9-volt transistor batteries when testing the *Crosley 50* (February, 1988 issue), *Billy Pogue* (Lake Havasu City, AZ) wrote to tell me about another successful blend of modern and vintage electronics. The lightweight 5-volt power supplies commonly used for solid-state circuitry, and widely available in surplus, are perfect for firing up the 01-A. Those supplies provide a well-filtered and well-regulated voltage. A unit rated at 1.5 amps will power a five-tube (1.25-amp draw) set without even running warm.



Such supplies are available from a variety of sources, and you may well see a suitable unit advertised in this issue of **HOE**. As a matter of interest, though, I just received "Flyer 136" from *Jameco Electronics* (1355 Shoreway Rd., Belmont, CA 94002), and it shows at least three supplies that could easily do the job with no trouble.

The most economical of the three that I homed in on is a surplus Coleco unit that (among other voltages) provides 5 volts at 3 amps. It's priced at \$9.95, and is ready to plug in—though you must supply a case if you want one. As of mid-February, Jameco had 800 of the unit in stock, and the flyer expires 5/31/88.

The Catalogue number is PS72559. Jameco does have a \$20.00 minimum order, so you'd have to need something else from the flyer to make the purchase worth-while.

When you think of the heavy, messy auto-storage batteries that the original owners used to power 01-A sets (or even of the 70-dollar, 20-pound, battery charger/eliminator I bought to do the same job in the 1960's), those little surplus units look like minor miracles!

### Transistorizing the Relics

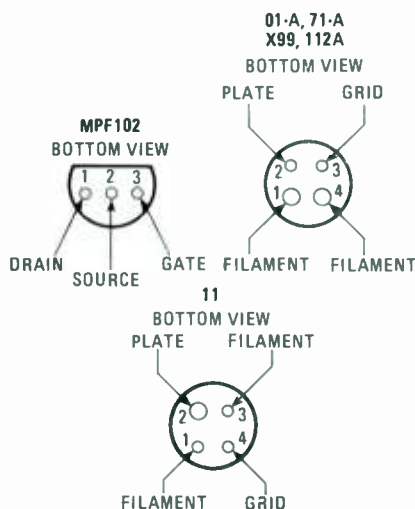
While we're talking about blending modern and vintage electronics, a couple of readers have written me about transistorizing old tube sets.

*Patrick Tracy* (Toledo, OH) writes that the MPF-102 (or equivalent) transistor can be used as a direct replacement for most of the tubes used in the old battery sets. He mounts the transistors in old tube bases, so they can be plugged in without modifying the vintage sets in any way.

Here's Pat's method in a nutshell—but because of wiring differences from set to set, you might have to work out your own variations. Just think of this as a guide to get you started.

First, obtain a set of tube bases to fit the set you want to transistorize. Wire an MPF-102 into each base (Fig. 1) as follows: gate to the grid pin; drain to the plate pin; source (in series with a 2.2K resistor) to either filament pin.

If you choose the filament pin that's connected to the filament-control rheostat, you'll be able to use the rheostat to turn the transistorized set "on" and "off." Multi-tube sets often have a couple of rheostats; one for the detector tube, the other for everything else.



**Fig. 1—Diagrams show base connections for MPF-102 transistor, 4-pin tube. Wire transistor to tube base as discussed in text.**

You'll have to turn both "on" or "off" to control the set's power.

The "on" position of the rheostats should not be at all critical, as long as each wiper arm is resting somewhere on its resistance element. When shutting the set off, be sure the wiper arms are turned all the way counter-clockwise, so that they are removed from contact with the resistance elements.

With the transistors in place, the set can now be powered from a 6-volt source, such as a lantern battery or four D-cells wired in series. Connect the A-, B- and A+ leads together (in most sets, B- and A+ leads are already common) and wire them to the negative terminal of your battery.

Connect all B+ leads together (many sets have a separate lead for the detector) and wire them to the positive terminal of your battery. Pat didn't indicate what should be done with any C+ or C- (which usually provides grid bias for the final audio stage) leads that might be present, but I'd assume they should be taped up and ignored. Any voltage applied to those leads would appear at the gate of an MPF-102—where it's not wanted.

If all goes well, your set should now be operable. But if it has a two-stage amplifier (as in the typical 5-tube 01-A set), your phones or speaker may be overloaded by too much audio. That is because the transistors provide more gain than tubes. To get around that problem, remove the grid lead from the secondary of the second audio transformer and connect it to the wiper arm of a one-megohm potentiometer.

Connect the resistance element of the potentiometer across the secondary of the second audio transformer. Now you can adjust the gain for a comfortable volume level for listening. Once you arrive at the right setting, you can ignore the potentiometer. Just leave it, temporarily wired, inside the set. You can remove it any time you'd like if you wish to return the set to its original configuration.

Alternatively, if your 5-tube set has a "first audio" output jack, you might be able to get adequate volume at that point—saving you from the bother of transistorizing the set and leaving its socket empty. Pat has used the MPF-102 to replace tubes in almost every type of circuit used in early battery sets. He hasn't adapted it yet for resistance-coupled audio amplifiers—but the early sets are virtually all transformer coupled, anyway.

That's a really neat trick, and I think I might try it myself in the near future so that I can give you a first-hand report about how it works. It certainly sounds like the answer for those who would like to try out an interesting radio, but can't locate needed tubes or don't want to acquire power supplies for the usual array of "A" and "B" voltages. And I especially appreciate the fact that the set need not be modified in any way, but can be returned to its original state in a matter of moments.

*Courtney Hall* (Dallas, TX), on the other hand, is into a much-more sophisticated transistorization scheme. He likes to use sets from the 1930's, 40's and 50's as opposed to modern ones. Besides being more interesting to look at, those older sets have lighted dials, more accurate station calibration and vernier tuning drives. But he doesn't like the heat the old sets gave off—or having to scrounge hard-to-find tubes or power-supply parts.

Making extensive use of dual-gate MOSFET transistors (such as the 2N4416), Courtney has worked out circuitry for replacing all tubes with solid-state equivalents. The original coils and IF transformers are retained in the modified version but, as you might imagine, the conversion irreversibly changes the radio from its original condition. So far, Courtney has transistorized a Hallicrafters S38-B and a Fada Model 209. And whether or not you agree with his conversion philosophy, you certainly

(Continued on page 100)



# CIRCUIT CIRCUS

**A simple, remote-control circuit takes the pressure off your "tired dogs!"**

□ IT'S ALWAYS FUN TO DO SOMETHING at one location and see the affect at another, without physically making contact at the second location. Feats of that nature performed discretely can make anyone look like a modern-day magician. So, this month I'll supply the remote-control circuit and you can figure out neat schemes using them so that you'll look like an electronic "Merlin."

The circuits are not all together magical, as each requires a wire "umbilical cord" to connect the two ends together. The main purpose of the circuits is to expand the number of things that can be controlled, from point "A" to point "B," without increasing the number of wires in an existing cable. That advantage can best be appreciated by those of us who've had the distasteful task of having to fish an additional wire cable from one room to another, following a path that would make marching through the maze in *Alice's Wonderland* look like a cake walk.

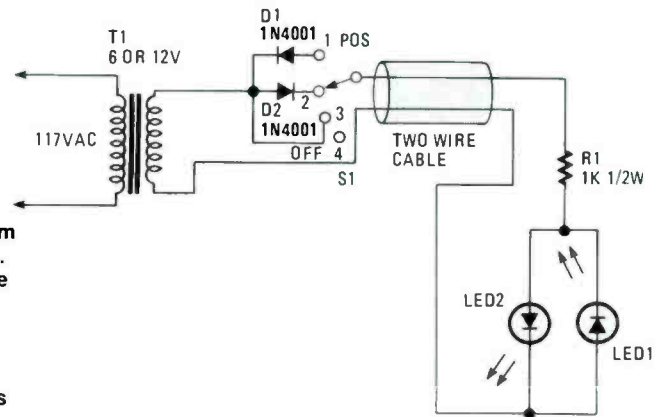
## DC-Load Remote Controller

Our first remote-control circuit (see Fig. 1) is about as simple as they come, and if all that's required is a choice of two or three functions and only one pair of wires is available, then a little magic may be enough. The circuit can be used to turn on or off both LEDs (which represent the device to be controlled) at a remote location.

The operation of the circuit is simple: Line voltage is fed across the primary of T1 (a low-current, 6- to 12-volt step-down transformer), which then appears at its secondary as a reduced voltage and is used to supply power to the remote circuit—in this case the two reverse-polarity, parallel-connected light-emitting diodes (LED1 and LED2).

Rotary switch S1 selects the remote functions and sends the proper signal through the two-wire cable. With S1 in position 1, D1 is forward biased, thereby supplying negative current to the

**Fig. 1—This simple circuit can be used for the control of low-power DC devices from some remote location. As shown, line voltage is fed across the primary of T1, which is used to supply power to the remote circuit. The remote function is selected via switch S1.**



load, forward biasing LED1. When S1 is set to position 2, a positive current is applied to the load, forward biasing LED2. Placing S1 in position 3 places an alternating current across the load. That AC, in turn, causes LED1 and LED2 to alternately light. Finally, when S1 is set to position 4, neither LED turns on. (Counting all of the switch positions gives us a four-function, remote-control system; not bad for a simple circuit.)

The circuit in Fig. 1 is just dandy for controlling light loads (like the two LEDs shown), but for a greater power capacity—say, two 117VAC, 100-watt or larger lamps—the circuit must be modified, somewhat, for it to operate properly.

## PARTS LIST FOR THE SIMPLE DC-LOAD REMOTE CONTROLLER

- D1, D2—1N4001 1-A, 50-PIV general-purpose silicon rectifier diode
  - LED1, LED2—Jumbo light-emitting diode (any color)
  - R1—1000-ohm ½-watt, 5% resistor
  - S1—Single-pole, four-position rotary switch
  - T1—6- to 12-volt stepdown power transformer
- Printed circuit or perfboard materials, battery, wire, solder, etc.

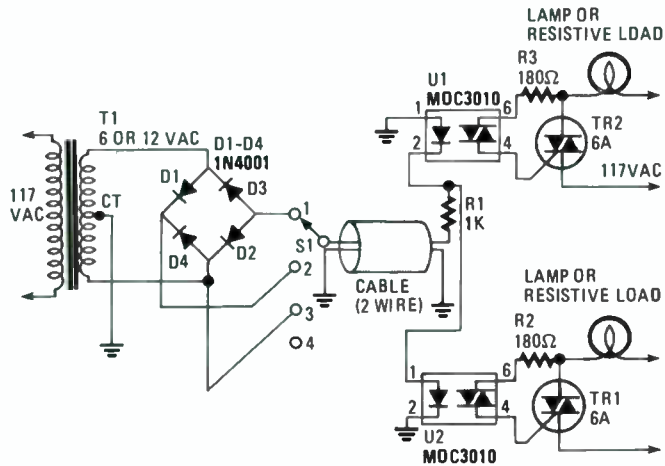
## AC-Load Remote Controller

The circuit in Fig. 2 is designed specifically to control AC-operated loads, while providing the same four functions afforded by the circuit in Fig. 1. Note, however, that two significant changes have been made: the original transformer has now been replaced by a center-tapped unit and D1 and D2 (in Fig. 1) are replaced by a bridge rectifier (consisting of D1–D4), which provides full-wave drive current to the remote-controlled, AC-lamp trigger circuits.

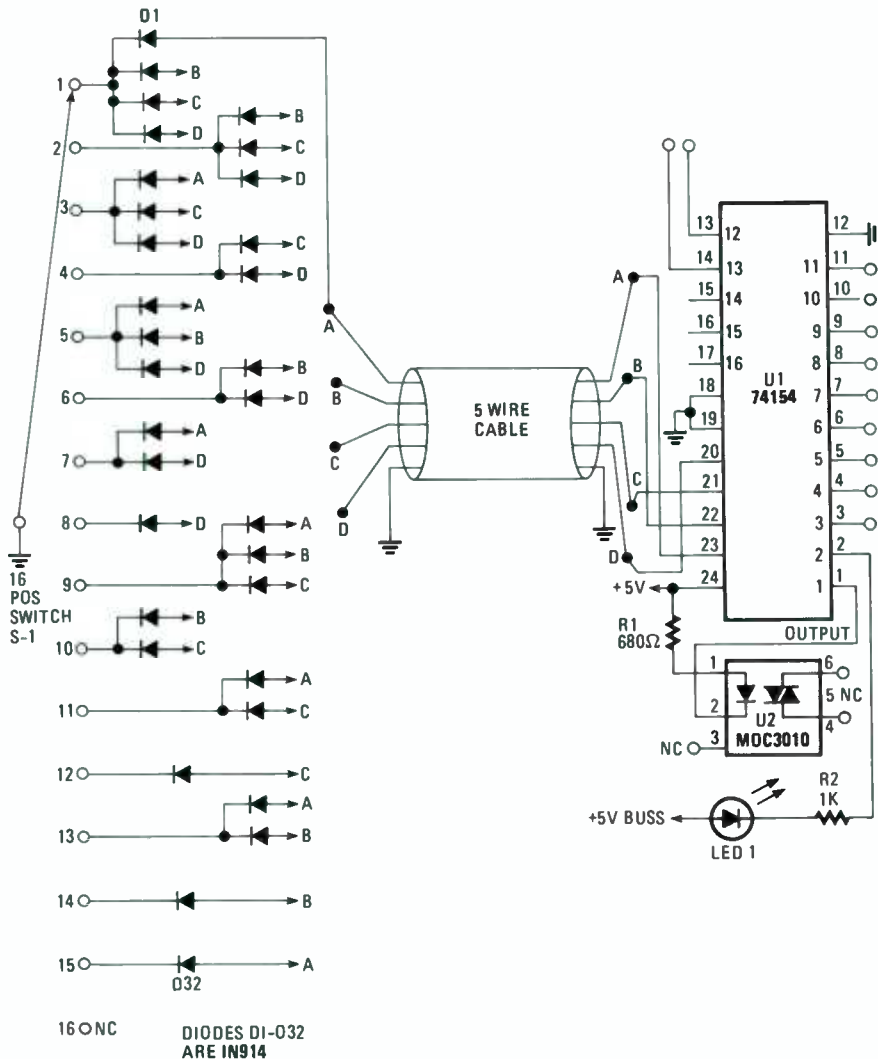
The triggering circuit consists of two triac triggers (diac or bilateral-switch output element) optoisolator/couplers, U1 and U2. If that triggering circuit were connected to the output of the circuit in Fig. 1 (in place of the LEDs), the LED inputs of each optoisolator/coupler would only see a half-wave current pulse in either position 1 or 2. The bilateral switches would follow in step, turning on the externally connected triac for only one-half of the AC cycle. You would see results in the low glow of the connected lamp. That, obviously, is not satisfactory.

The full-wave drive circuit in Fig. 2 solves that problem by supplying U1 and U2 drive current during both halves of the AC cycle. With S1 in position 1, negative full-wave drive current turns on U2 (which then turns on TRI), caus-





**Fig. 2**—Other than being designed specifically to control low-current AC-operated loads, this circuit is identical in operation to the circuit shown in Fig. 1. To accomplish that feat, the original transformer (see Fig. 1) was replaced by a center-tapped unit, D1 and D2 were replaced by a bridge rectifier (D1–D4), and two triac trigger optoisolator/couplers (U1 and U2) have replaced the LEDs.



**Fig. 3**—This remote-control circuit allows the selection of one of sixteen functions from a remote location via a 5-conductor cable, using a switch-selected BCD (Binary-Coded Decimal) signal, which is sent to a decoder at the remote location. The signal is decoded (or interpreted) by U1 to activate the desired function.

### PARTS LIST FOR THE SIMPLE AC-LOAD REMOTE CONTROLLER

- D1–D4—1N4001 1-A, 50-PIV general-purpose silicon rectifier diode
  - R1—1000-ohm ½-watt, 5% resistor
  - R2, R3—180-ohm ½-watt, 5% resistor
  - S1—Single-pole, four-position rotary switch
  - T1—6- to 12-volt stepdown power transformer
  - TR1, TR2—6-A triac (see text)
  - U1, U2—MOC3010 triac driver optoisolator/coupler, integrated circuit
- Printed circuit or perfboard materials, battery, wire, solder, hardware, etc.

ing the lamp connected across its main terminals to burn at full brightness. The same holds true for U1 when S1 is placed in position 2.

A slight problem occurs when S1 is placed in position 3 to turn both lamps on at once. Since drive current is taken directly from T1 (in AC form), U1 and U2 each receive operating current during only half of each cycle. It therefore follows that each lamp will operate at only half brilliance.

### Sixteen Function Remote

The remote-control circuit in Fig. 3 allows the selection of 1-of-16 functions from a remote location through a five wire cable. That "magical," but simple, feat is accomplished via a switch-selected BCD (Binary-Coded Decimal) signal, which is sent to a decoder at the remote location. That signal is decoded (or interpreted) by U1 to indicate the desired function.

At the control end a single-pole, 16-position rotary switch selects the correct four-bit code that's fed through the cable to the receiving end. Low-cost silicon diodes are used to offer the necessary circuit isolation from terminal on the output of switch S1.

At the receiver end, a 24-pin 4-to-16 line decoder/demultiplexer (U1) looks at the 4-bit code and selects the correct output to match the position of S1 at the control end. All outputs (excluding the selected one) are normally in the logic 1 state—which can be checked with a voltmeter—and should measure 5 volts. The selected output position will be pulled to ground by U1 and should read zero volts.

If you want to keep up with U1's output status, while experimenting or

## CIRCUIT CIRCUS

troubleshooting the circuit and you've had it with the voltmeter scene, then connect a 1000-ohm resistor and LEDs (as is done for output 2 at pin 2 in Fig. 3) between each of U1's 16 output terminals, and the 5-volt bus. The 16-LED indicators can be permanently connected to the circuit for future use without adversely affecting the operation of the circuit connected to the outputs of U1.

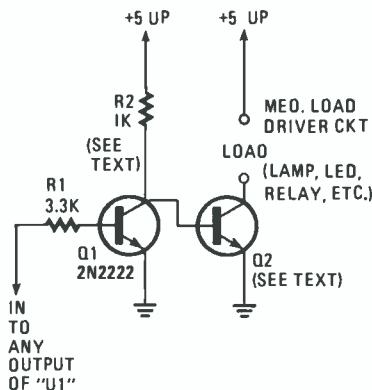
Anything that can be turned on or off through a relay, optoisolator/coupler, transistor, or similar switching device can be controlled with this circuit. An MOC3010 is shown connected to output 1 (pin 1) of U1, and can be used to turn on or off just about any AC-operated device.

### PARTS LIST FOR THE 16-FUNCTION REMOTE CONTROL

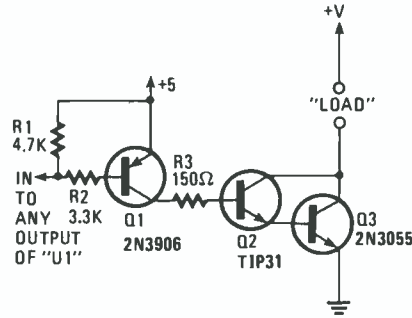
D1-D32—1N914 general-purpose small-signal silicon diode  
 R1—680-ohm ½-watt, 5% resistor  
 R2—1000-ohm ½-watt, 5% resistor  
 S1—Single-pole, 16-position rotary switch  
 U1—74154 4-to-16 line decoder/demultiplexer, integrated circuit  
 U2—MOC3010 triac driver optoisolator/coupler, integrated circuit  
 Printed circuit or perboard materials, battery, wire, solder, hardware, etc.

### High-Powered DC Adapters

Refer to the circuit in Fig. 4. Note: The base of Q1 is assumed to be connected to an output of U1 in Fig. 3. The



**Fig. 4**—This circuit, which responds to positive base-bias current, can be added to the circuit in Fig. 1 (replacing the LEDs) to allow the control of DC-operated devices having heavier power requirements than might be otherwise be handled by the original circuit alone.



**Fig. 5**—This circuit, which is operationally identical to the circuit in Fig. 4 (except that it is triggered by a negative base-bias current), can be added to the circuit in Fig. 1 (in the same manner) to allow the control of DC-operated devices with heavier power requirements.

### PARTS LIST FOR THE HIGH-POWER DC ADAPTERS

#### FIG. 4

Q1—2N2222 general-purpose NPN silicon transistor  
 Q2—NPN transistor, see text  
 R1—3300-ohm, ½-watt, 5% resistor  
 R2—1000-ohm, ½-watt, 5% resistor

#### FIG. 5

Q1—2N3906 general-purpose PNP silicon transistor  
 Q2—TIP31 NPN silicon power transistor  
 Q3—2N3055 NPN silicon power transistor  
 R1—4700-ohm, ½-watt, 5% resistor  
 R2—3300-ohm, ½-watt, 5% resistor  
 R3—150-ohm, ½-watt, 5% resistor  
 Printed circuit or perboard materials, wire, solder, hardware, etc.

outputs of U1 in the non-activated state, are near the 5-volt level. Transistor Q1 is biased on through R1 by the 5-volt output of U1, pulling its collector voltage to ground potential. Thus, no bias is applied to the base of Q2 and the load connected in Q2's collector circuit is idle. When U1's output is activated, the bias is removed from Q1's base, allowing its collector voltage to rise. Bias current (via R2) is supplied to the base of Q2, turning it on and activating the load.

The load voltage and current requirements dictate the size and type of transistor used for Q2. For light loads with a supply voltage of 15-volts or less, and a maximum load current of 100 mA, a 2N2222 will do, but for current levels above 1 ampere, a power Darlington would be a good choice. Try a TIP120 NPN high-gain Darlington that's available from Radio Shack (part #276-2068).

The driver in Fig. 5 is best suited for

high-current DC loads. This circuit's operation is very similar to the previous one, with the exception of transistor Q1, which is a PNP type. With the proper size heatsink, transistor Q3, a 2N3055 unit, can handle load currents of over 10 amperes.

### Ten-Function Remote Control

Would you believe a two-wire ten-function, remote-control circuit? You bet you can! Take a look at Fig. 6 and you'll see a real workhorse of an IC (the LM3914 dot/bar display driver) that is performing a job that's somewhat different than the job that it was originally designed to do.

The LM3914 has many hidden talents that can place it in a number of unusual circuits, and our little remote control is no exception. As a matter of fact, two or more LM3914s can be connected in cascade to increase the number of remote-controlled outputs to 20 for the same two-wire circuit. Interesting? Before moving on (placing the cart before the horse, so to speak), lets see how the circuit operates.

### PARTS LIST FOR THE 10-FUNCTION REMOTE CONTROL

C1—0.1-μF, 100-WVDC Mylar capacitor  
 R1—50,000-ohm potentiometer  
 R2-R13—1000-ohm, ½-watt, 5% resistor  
 R14—680-ohm, ½-watt, 5% resistor  
 S1—Single-pole, 10-position rotary switch  
 U1—LM3914 dot/bar display driver, integrated circuit  
 U2—MOC3010 triac driver optoisolator/coupler, integrated circuit  
 Printed circuit or perboard materials, wire, solder, hardware, etc.

The LM3914 takes a linear input voltage and gives a digital 1-of-10 output that corresponds to the input-voltage level. With the components specified, the voltage range is about 1.2-volts per step. At the control end, a string of ten 1000-ohm resistors are connected in series with a 50,000-ohm calibration potentiometer and a regulated 5-volt source.

The ten-position rotary switch (S1) selects the voltage and sends it through the two-wire cable to the input of U1. In turn, U1's output voltage for the selected position is pulled to ground potential, activating the load circuit just as

(Continued on page 102)





By Marc Saxon

# SAXON ON SCANNERS

## Realistic's handheld scanner tackles the hobbyist market

□ WITH ALL THE SCANNERS AND RELATED products to hit the market in recent times, few have been aimed at the newcomers to this fun-filled hobby. And advertisements—chock full of PR hype, usually written in *broken technese*—are of little help to the beginner. Confusion is a way of life for the newcomer to the communications hobby. But as someone once said, "create a void and someone will rush in to fill it."

The latest manufacturer to attempt bridging the gap between *maven* and beginner is Realistic with their PRO-32 (Radio Shack's in house brand)—a handheld scanner designed with the hobby user in mind. The PRO-32 has pretty-near everything from 200-channels in ten selectable banks to a glitzy brushed-silver faceplate.

Its scanning range is awesome and includes 30-to-54 MHz, 108-to-136 MHz, 138-to-174 MHz, and 380-to-512 MHz; a big bite of spectrum, to say the least. The rig has a search/scan mode, a priority key for selecting one channel that you want to monitor with special attention, and (naturally) it's fully keyboard programmable. Up to ten frequencies located during a search/scan session may be stored on channels in the monitor bank, and can later be easily transferred to the PRO-32's permanent memory.

More than just a pretty face, the PRO-32 has individual channel lockouts, selectable scanning rate (4 or 8 channels per second), and a keyboard lock to prevent accidental reprogramming. There's a large multi-purpose LCD display that shows which channel and frequencies are being scanned, as well as channel status (delay or locked out), and the operational mode in which the PRO-32 is functioning (scan, search, or programming).

The antenna is a rubberized job with a BNC-type connector. Power is supplied by six AA-type batteries. Adding the PRO-32's flexibility is its AC adapt-



CIRCLE 77 ON FREE INFORMATION CARD

**The Realistic PRO-32 (from Radio Shack) has an awesome scanning range, which includes 30-to-54 MHz, 108-to-136 MHz, 138-to-174 MHz, and 380-to-512 MHz. Other features of the rig include a search/scan mode, a priority key, a 10-channel monitor bank, individual channel lockouts, selectable scanning rate, a keyboard lock, a large multi-purpose LCD display, rubberized antenna with BNC connector.**

er/charger, whereby rechargeable batteries can be re-energized. It also has a DC adapter for operation from a vehicle. Three silver-oxide button batteries are supplied to provide memory backup power (although it will retain its programming for thirty minutes even without memory backup batteries).

The PRO-32 is an excellent scanner, and although it's priced in the \$300 range, it offers many features and superior performance thanks to design extras like crystal and ceramic IF filters. See one at any Radio Shack store.

### The Official Scoop

In the March issue I made reference to frequencies used by the New York City Transit Authority (NYCTA) subway frequencies. That brought in an enlightening letter from Dr. Stephen Dobrow, Fairleigh Dickinson University, Teaneck, NJ.

Dr. Dobrow passed along a copy of a frequency list sent to him from the head of the NYCTA to share with our readers. Communications relating to general subway operations throughout the NYCTA systems take place on the following frequencies: 158.775, 158.805, 158.88, 160.395, 160.845, 160.875, 161.025, 161.19, 161.505, and 161.565 MHz. The Transit Police use 151.145, 151.19, 151.31, 151.34, 160.305, 161.50, 160.515, 160.695, 160.905, and 160.965 MHz. That considerably adds to the information we'd shown in March.

### The Simplicity of Simplex

Readers have frequently written to ask why sometimes they can monitor distant mobile units while at other times, a mobile unit much closer comes in poorly or not at all. That means it's time to say a few words about the different communications systems one normally encounters on the scanner bands. For instance, *simplex* and *duplex*.

A simplex system is one where the dispatcher and all of the mobile units transmit and receive on the same frequency. You may find sometimes that distant mobile units in such systems are out of the range of your receiver's capabilities. And even though the dispatcher may well have a higher and more efficient antenna than yours, the mobile units may sometimes venture beyond the dispatcher's signals from quite far away.

Many systems use a duplex arrangement—that is, the dispatcher transmits (Continued on page 105)



By Joseph J. Carr, K4IPV

# CARR ON HAM RADIO

## Make long-wire antennas really work using some old techniques

□ YOU'VE HEARD IT DOZENS OF TIMES: the random-length long-wire antenna is the "perfect" solution to awkward antenna problems. Whether it's a lack of real estate, cranky landlords, or a profound lack of bucks, the long-wire will do the job for you. Right? Well, now, that depends on who you ask and what they did to make it work ... or not work.

One person says the long-wire is not worth a plugged nickel; another is very ho-hum about it because his kinda works; still another is enthusiastic because hers is installed correctly and it works better than anything since sliced pickle and liverwurst sandwiches. Over the years my various living arrangements have forced me to use long-wires at many QTH's, as well as on Field Day. Why does the random-length long-wire have such a varied reputation? Before we attempt to answer that question, let's find out (for those who came in late) just what is a long-wire antenna.

### Long-wire Antennas

Long-wire antennas are any of several types of resonant and non-resonant antennas. Any given long-wire antenna may be both resonant and non-resonant, depending upon the operating frequencies used. In the "old days," when I was first getting started in amateur radio, most resonant long-wires were resonant over all HF bands because those bands were harmonically related to each other. But with the addition of the

10, 18, and 24-MHz band segments that relationship no longer holds true for all cases.

Figure 1 shows the classic random-length, non-resonant long-wire antenna. It consists of a wire radiator that is at least a quarter-wavelength long, but is most often longer than a quarter-wavelength. The specific length is not critical, but it must be greater than a quarter-wavelength at the lowest frequency of operation anticipated. If you have a 90-foot wire, it will work on all HF bands above 3.5-MHz.

In most installations the wire is #12 or #14 Copperweld or hard-drawn copper wire. I have successfully used both #12 and #14 house wiring, but because it is solid (not stranded) it is not the best material. Stranded wire lasts longer in the wind because solid wire fatigues and breaks quicker.

The long-wire antenna is capable of providing a gain advantage over a dipole and a low angle of radiation (which is great for DX operators!). But those advantages are only found when the antenna is cut to be many wavelengths long, and so they only occur on typical HF antennas in the 21- through 29-MHz bands.

The long-wire is end-fed, and therefore has a high impedance, except in those cases where the radiator happens to be a quarter-wavelength. Because of that fact, it is necessary to use an antenna tuner between the low-impedance

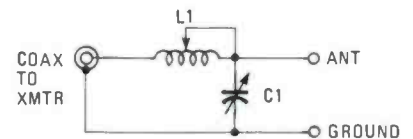


Fig. 2—The typical antenna tuner (L-section coupler) for long-wire installations, as shown here, consists of a series inductance and a shunt capacitance, both of which are variable.

transmitter output (usually limited to a 50- to 75-ohm impedance) and the antenna. You can buy any of several commercial antenna tuners, or make one yourself.

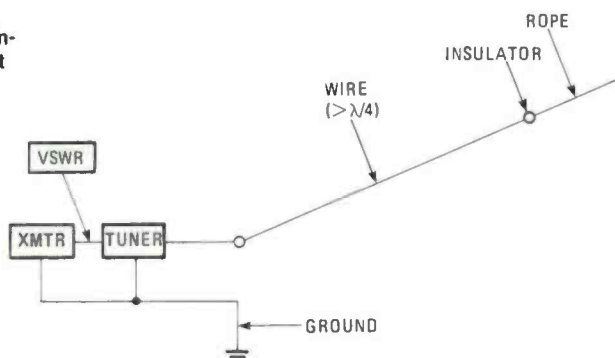
### Building a Tuner

Figure 2 shows a typical antenna tuner for long-wire installations. It is an L-section coupler, consisting of a series inductance and a shunt capacitance, both of which are variable. The inductor can be homemade, or made from a B&W miniductor (the 3029 is suitable for that). Alternatively, often you can buy a used roller inductor at a hamfest or from Fair Radio Sales (Box 1105, Lima, OH 45802), or a new roller inductor can be obtained from Radiokit (Box 973, Pelham, NH 03076).

If you opt for the homemade or miniductor alternatives, then an alligator clip lead (short!) connected to one end of the coil can be used to short-out unnecessary turns when adjusting the inductance. I personally prefer the roller inductor method because it allows the whole *shootin' match* to be installed inside of a shielded cabinet, which greatly helps to keep the TVI/BCI situation under control.

The capacitor you select (also available from the same sources) should be 150-pF to 250-pF maximum capacitance, and be a high-voltage variable type. So-called "transmitting variables" are usually OK if the plate spacing is adequate; it should be at least 1/8-inch. Tuning of the long-wire is simplicity itself.

Fig. 1—Shown here is the classic random-length, non-resonant long-wire antenna, consisting of a wire radiator measuring at least a quarter-wavelength long.





If the antenna tuner you are using does not have a built-in VSWR meter, then you should install one in the line between the transmitter output and the tuner input. Adjust both L1 and C1 (they are a bit interactive so you may have to do it several times) for lowest VSWR. If you use the alligator clip method, *turn off the "darn" transmitter before adjusting the clip's position*—RF burns are nasty.

### So What's the Problem?

OK, so we have decided to install a long-wire. How do we make it work? First, make sure that it is long enough. The bare minimum lengths for HF bands are 70-feet for 3.5-MHz and up, 34-feet for 7-MHz and up, and so on. In general, the longer the wire the better (see below).

The second problem is a good ground. The importance of a good ground cannot be underestimated, and differences in ground quality accounts for about 99-percent of the difference in reported performance of long-wires.

A good ground consists of a short wire to either one very long ground rod, or multiple ground rods spaced a couple of feet apart. An important factor is the length of the ground wire. It must be considerably less than a quarter-wave-length. To obtain the best results, use



The Model MFJ-931 artificial RF ground (pictured here) is series connected in the antenna ground return line and is used to tune the ground wire.

#10 stranded wire (several parallel lengths) or braid.

When I was in college, I lived on the second floor of a wacky student boarding house in Norfolk, VA. The ground was 24-feet away, and that made the mere thought of a "short ground wire" a joke...and my long-wire nearly inoperable. But I figured out a way around the problem. A quarter-wave radial was dropped out the window (see Fig. 3). Use more than one radial if possible. In one case, the landlord was particularly cranky, so I tacked the radial to the baseboard of my room (of course, it was insulated on standoffs at the far end

against the high RF voltages present). It worked well!

A new product (see photo) also comes to the rescue of those readers who cannot put up a good long-wire—the Model MFJ-931 artificial RF ground (price: \$79.95) from MFJ Enterprises (Box 494, Miss. State, MS 39762, 1-800-647-1800). That device is installed in the ground line (See Fig. 4), and is used to tune the ground wire.

To use the unit, adjust the capacitance and inductance controls for maximum ground current as shown on the built-in meter. Follow the instructions, however, because high RF voltages can appear on a non-resonant ground wire. I wish I'd had one of those gadgets when I was in that wacky boarding house...discussing existentialist poetry can't hold a candle to DXing.

### An Important Exception

The one exception to "the longer the better" rule of thumb is when your station is located near power lines or in a thunderstorm-prone region. Induction from nearby power lines can be horrendous! And even distant thunderstorms can cause problems. The late John Thorne (K4NFU/5), who experimented with many forms of antenna, related how he put up a 1000-foot long-wire on his Austin, TX property. Thunderstorms 20-miles away could induce enough static to draw a spark, so he placed a 10-megohm, high-voltage resistor from the center point to ground. It was RF-neutral, but drained the electrostatic charge.

Joe Carr, K4IPV, can be reached at PO Box 1099, Falls Church, VA 22041; don't forget that he would like to have your comments and suggestions for this column. ■

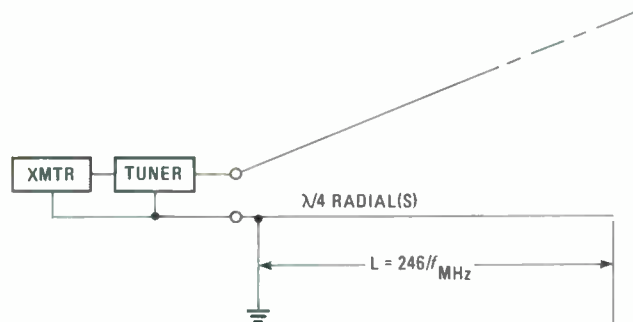


Fig. 3—A good ground consists of a short wire to either one very long grounding rod, or multiple grounding rods spaced a couple of feet apart. A quarter-wave radial (connected to the ground lead) also helps to relieve the grounding problems.

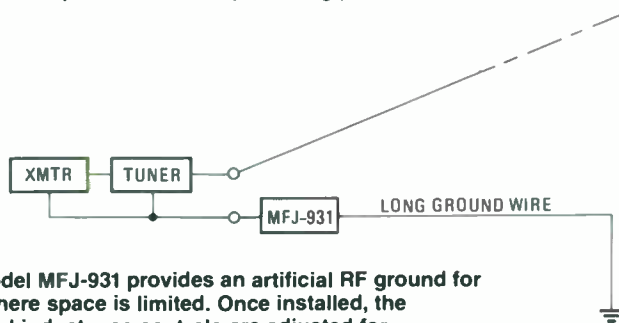


Fig. 4—The Model MFJ-931 provides an artificial RF ground for installations where space is limited. Once installed, the capacitance and inductance controls are adjusted for maximum ground current as shown on the unit's built-in meter.



By Don Jensen

# JENSEN ON DX'ING

## The SW swap-shop goes full swing as broadcasters reach out to grab DXers

□IT'S TRADING TIME FOR A GROWING number of international shortwave broadcasters. *Radio Japan* and *Radio Canada International (RCI)*, for example, are swapping air time. Similar agreements are operating between *Radio Beijing* and several major European SW broadcasters. There are a number of international stations already relaying—or negotiating to do so—their shortwave programs via overseas transmitters belonging to other broadcasters.

The reason for that trend is simple. In this era of superpower shortwave broadcasting and increased interference on the bands, it has become essential for stations to establish transmitting operations closer to their intended audiences to be sure they are served with loud and clear signals.

Overseas relays, of course, are nothing new in shortwave broadcasting. Decades ago, major governmental SW voices began building their own relay transmitters in places such as the Philippines, Liberia, Singapore, and Madagascar to better beam their signals into the more remote corners of the world.

Today, the strongest signals North American SWLs hear from the *BBC*, *Deutsche Welle* and *Radio Nederland* are, in fact, not coming directly from England, West Germany or Holland, respectively, but are relayed by powerful transmitters in this hemisphere.

But it is expensive for a broadcaster to build and operate its own series of overseas relay transmitters. A less-costly solution for a station is to swap air time with fellow broadcasters abroad. You relay my programs for a certain number of hours daily and I, in turn, will relay yours, each of us using our own existing transmitters for the exchange.

For some time, for instance, Taiwan's *Voice of Free China (VOFC)* has had an exchange with the U.S. religious shortwaver (*WYFR*) *Family Radio*,



This postcard from HCJB shows four views of the longtime Gospel broadcaster in Quito, Ecuador. The top views are of the Vozandes Hospital operated by the religious organization. At the bottom left is the station's impressive antenna farm at Pifo, just outside the Ecuadorian capital. The photo on the lower right is the HCJB station compound from which its programming originates.

which has powerful shortwave transmitters in Florida. *WYFR*'s Chinese programming is aired for listeners on the China mainland by a VOFC transmitter on Taiwan—6,565 kHz at about 2100 to 2300 UTC, for example.

And U.S. and Canadian listeners get strong reception of the Voice of Free China's English programs nightly from 0200 to 0400 UTC on 5,945 and 5,985 kHz, the flip side of the deal.

A similar swap was begun last year between *Radio Japan* and *Radio Canada International*. RCI's programming to the Far East is relayed by Japan's NHK transmitter site at Yamata at 2200 UTC on 17,885 kHz and at 1200 UTC on 17,810 and 15,290 kHz.

*Radio Japan*'s English programming comes in strong signals in North America thanks to the Canadian half of the agreement. Trans-Pacific satellite feeds provide the programs that are relayed by RCI's station at Sackville, New Brunswick at 0300 UTC on 5,960 kHz.

The current king of the air time swaps

is China's *Radio Beijing*. Several years ago, the Chinese negotiated with a private U.S. shortwave broadcaster, *WRNO* in New Orleans, but the relay agreement never materialized.

Then Beijing briefly had a rebroadcasting agreement with the French and English, wherein programs from the Chinese SWer were heard via a relay from the *Radio France International (RFI)* transmitters at Montsinery, French Guiana in South America. Political difficulties arose in France over the deal, however, and it was quickly nixed.

Late in 1987, though, *Radio Beijing* did manage mutually advantageous air time exchanges with both Switzerland and Spain. As a result, *Swiss Radio International (SRI)* programs aimed at Asian listeners are being rebroadcast from Chinese stations from 1315 to 1500 UTC—in English at 1330 UTC—on 11,695 and 15,135 kHz.

Beijing's programs in German, French, Italian and English are, in turn, being relayed from SRI transmitters in



Switzerland from 2100 to 2300 UTC on 3,985 and 6,165 kHz.

Beginning early this year, a 120-kilowatt Chinese station at Xian began broadcasting programs of the *Spanish Foreign Radio* (SFR) to Japan and the Philippines on an experimental basis from 1000 to 1100 UTC on 7,165 kHz, and 1100 to 1200 UTC on 11,870 kHz.

The other side of that arrangement was to have Radio Beijing English programs to North America relayed from the Spanish shortwave facilities at Noblejas on 9,630 kHz at 0500 to 0600 UTC.

The Noblejas facility also was expected to figure in another relay exchange being negotiated between Spanish Foreign Radio and *Radiodifusion Argentina al Exterior* (RAE). If finalized, RAE transmitters would air Spain's broadcasts to Latin listeners, while Argentine programming would be relayed by SFR's Iberian stations and one at Tenerife in the Canary Islands.

### Botswana's Bogus Bossy

Before it gained independence and changed its name to Botswana, the little British protectorate in southern Africa was called Bechuanaland. Broadcasting grew from a police radio network to a station called *Radio Mafeking*. By the time Botswana came into being in 1966, *Radio Bechuanaland* was operated from a room above the post office in Garorone, the new capital. Two years later *Radio Botswana* was housed in the former home of a prime minister.

Today's Radio Botswana stems from a merger of the shortwave station and the national information service in 1978. With 50-kW transmitters, this African station generally puts a rather good signal into North America during our nighttime hours.

Each day the station greets its rural African audience at sign-on with a chorus of bovine mooing, some clanking cowbells, and similar rustic sounds. This recorded rustic IS has always seemed remarkably realistic too. But, according to Canadian DXer Robert Ross, there's more than a little baloney behind Radio Botswana's unusual tuning signal.

One day last fall, Ross was talking to a group of Canadian radio amateurs about shortwave programming. "During my talk," Ross relates in the Ontario DX Association's *DX Ontario*

publication, "I mentioned interval signals and said that if you ever hear Radio Botswana's, you'll never forget it."

Ross was surprised at the reaction of one of the hams in the audience, Ian Kennedy, VE30NK, an electronics instructor at Fanshawe College in London, Ont. He laughed uproariously.

### ABBREVIATIONS

<b>AIR</b>	All India Radio
<b>BBC</b>	British Broadcasting Corporation
<b>DX</b>	long distance (over 1000 miles)
<b>DX'er</b>	listener to shortwave broadcasts
<b>DX'ing</b>	listening to shortwave broadcasts
<b>IS</b>	interval signal
<b>kHz</b>	kiloHertz (1000 Hertz or cycles)
<b>kw</b>	kilowatt (1000 watts)
<b>RAE</b>	Radiodifusion Argentina al Exterior
<b>RCI</b>	Radio Canada International
<b>RFI</b>	Radio France International
<b>RHC</b>	Radio Havana Cuba
<b>RN</b>	Radio Nederland
<b>SFR</b>	Spanish Foreign Radio
<b>SRI</b>	Swiss Radio International
<b>SW</b>	shortwave
<b>SWL('s)</b>	shortwave listener('s)
<b>US</b>	United States
<b>UTC/GMT</b>	Universal Time Code/ Greenwich Mean Time
<b>VHF</b>	very-high frequency
<b>VOFC</b>	Voice of Free China
<b>VOK</b>	Voice of Kenya
<b>WYFR</b>	Family Radio

Later, Ross spoke to Kennedy and learned that the ham formerly was Radio Botswana's chief engineer. "He apologized for laughing," Ross recounts, "but said he couldn't help it because *he* was the cow."

Kennedy explained that he had made the moos while other staffers contributed assorted barnyard noises and a friend banged away on the cowbell. That recorded snippet has been used as Radio Botswana's IS ever since and the counterfeit cow went undetected by SWLs until Kennedy revealed his little deception. If you want to hear it for yourself, tune in on 7,255 kHz five or ten minutes before Radio Botswana signs on at 0400 UTC.

### Down the Dial

Here's the spot where each month we feature your reports about what you are hearing on the shortwave bands. Send your loggings to *Jensen on DXing*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

Also any questions about stations heard or other SWLing subjects are welcomed and I'll try to answer them in a future column.

**Antarctica**—15,474 kHz. *Radio Nacional Arcangel* San Gabriel is an exotic bit of DX. It's location, despite the name, is Antarctica, where Argentina has established a military base. Given its nationality, it's not surprising that all programming is in Spanish. It can sometimes be heard with reasonably good signals at about 2300 UTC.

**Cuba**—5,025 kHz. Most listeners are familiar with the programs of powerful *Radio Havana Cuba* (RHC), which can be easily heard on shortwave. Less well known is *Radio Rebelde*, a shortwave relay of a Spanish language domestic Cuban network. Look for it here around 0300 UTC, with the identification, "rebelde, La Habana."

**East Africa**—6,100 kHz. A nice bit of DX on the 49-meter band is the *Voice of Kenya* (VOK), broadcasting from east Africa around 2030 until past 2100 UTC, with English language news on the hour.

**India**—7,412 kHz. This is one frequency to try if you're looking for *All India Radio*. You can find English language news at 2200 UTC.

**Monoco**—7,105 kHz. *Trans-World Radio* is a worldwide religious organization that operates shortwave stations in such widespread locations as the Netherlands Antilles and Sri Lanka. One of its early broadcasting sites (in operation for decades now) is Monoco, the tiny principality on the Mediterranean coast better known for its casinos. This station signs on the air, in English, at 0630 UTC.

**Pakistan**—11,615 kHz India, Sri Lanka, and now another south Asian station, *Radio Pakistan* can be heard broadcasting on this frequency from Islamabad, from 1600 UTC with news and commentary in English.

**Sri Lanka**—9,720 kHz. *The Sri Lanka Broadcasting Corporation* has been reported here from 1230 UTC with an English identification, a musical interlude, and religious programming. The news follows at 1300.

**Credits:** Richard D'Angelo, PA; Charles Rippel, VA; Mike Hardester, PA; Paul Bauer, FL; Robert Ross, ONT, Canada; John Tuchscherer, WI; North American Shortwave Association, 45 Wildflower Road, Levittown, PA 19057) ■



By Herb Friedman

# FRIEDMAN ON COMPUTERS

## Control your Hi-Fi with your PC.

□ FOR YEARS WE'VE BEEN HEARING how *nirvana*, or at least the "Golden Age," will arrive when personal computers run everything in our home—from making coffee in the morning using stale water that's been sitting in a pot all night, to changing kitty's litter-box. Fortunately, except for using a personal computer as a voice-mail system, few, if any, of the "just another appliance" prognostications have come to pass.

The reason computerization of everyday life has met with underwhelming enthusiasm is not so much that the applications are stupid—some actually do have intrinsic value—but it simply doesn't make sense to tie up several thousand dollars worth of computer hardware to do something that is more easily accomplished with an inexpensive dedicated device.

For example, I once ran across an article showing how to use my—at that time—\$2500 IBM-PC to control my home's heating and air-conditioning system. I accomplish the exact the same thing, with much less fuss and bother, by using an under-\$100 Honeywell computerized thermostat. Why, in Heaven's name, would I tie up an IBM-PC on a 24-hour basis to control my home's heating and air-conditioning?

### Another Appliance

But time and circumstances do change, particularly when it comes to personal computers. Today, it's possible to purchase a complete floppy-disk-based IBM-compatible computer for about \$500, which is less than the cost of some common household appliances. It's also possible to purchase software and hardware specifically designed so that non-technical users can control entertainment devices. (That's a far cry from telling someone to connect a relay to parallel-port terminal 16 and then call in an electrician and plumber to connect your heating system to the



The Revox B203 Timer Controller is basically an infrared remote control system for the Revox 200-series hi-fi components. But it can also allow all of the components to be controlled by an IBM-compatible PC on a date, time, equipment, and specific cassette-timer basis.

parallel port's relay so that the heat comes up when the terminal goes high.)

Aha! You can't figure out what I'm driving at. OK, I'll tell you. I'm getting to the Revox B203 Timer Controller for hi-fi equipment, which happens to be software compatible with IBM-type PCs. The B203 unit (shown in the photograph) is an infrared-remote controller for Revox's new line of hi-fi components. It also connects to a PC, and can be automatically driven by the PC during times it would not normally be used.

First off, for those of you unfamiliar with the name "Revox," it's the brand name for the non-professional gear manufactured by Studer, the outfit that produces the world's best recording-studio equipment.

Studer-Revox hardware has always been a leader in design, performance, and price, so they don't hesitate to suggest using a \$500 PC to control their hi-fi gear, since any single item costs considerably more than the PC. (For those of you interested in the cost of Revox hi-fi equipment, I can only quote the words of the Great Robber Baron, J.P.

Morgan. When asked how much it cost to run his yacht, he replied to the effect that if you had to ask how much it cost you couldn't afford one.)

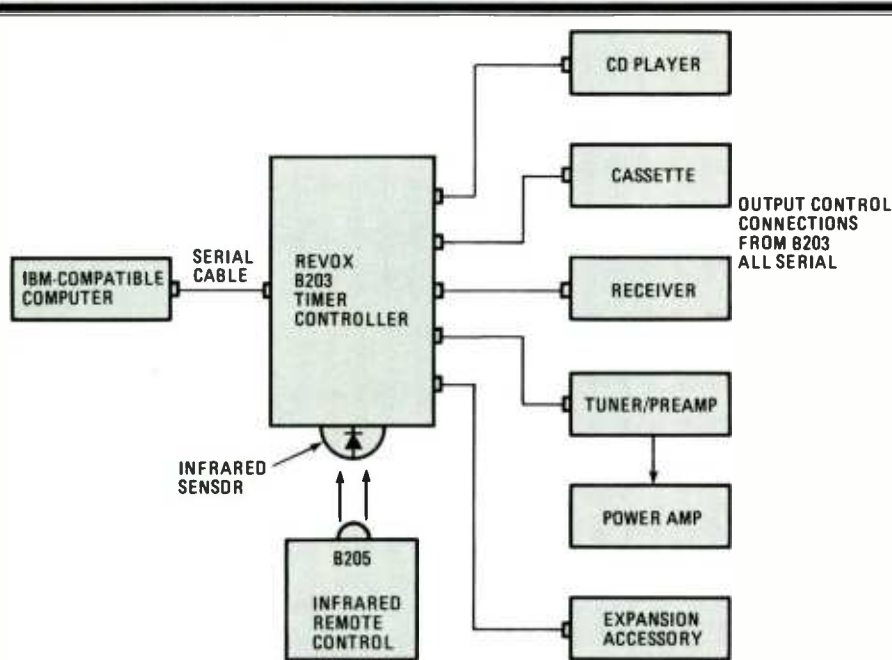
What Revox did was to computerize their 200-series hardware—the receiver, tuner/preamplifier, power amplifier, cassette deck, and compact-disc player—in such a way that they could be remote-controlled by their B203 Timer Controller, using a hand-size B205 remote control. But, and it's a big *but*, the 200-series hardware can also be controlled by a B203 that in turn is under the software-control of an IBM-compatible PC.

The software allows the user to write what is essentially an operating script. For example, it might have the FM tuner switch to preselected stations at specific times, feed the sound to a speaker or a recorder, or even intermix FM and specific programs or tracks from cassettes and CDs.

### Status Reports

What's nice about the Revox system is that you can program status conditions into your script. For example, if





**Fig. 1—All the equipment and computer connections to the Revox Timer Controller are made through ordinary bi-directional serial ports. No unusual relay connections, or user wiring or jumpering of any kind is necessary. Just plug it all together and it works the first time out.**

you want the cassette deck to play a complete 23-minute, 10-second tape track before stopping or playing a CD, you could write into your script a request for a status report from the cassette deck at 23:10.

The PC will stop, or hold off switching in the CD player until it receives a status report that 23:10 worth of music has been played. In effect, the system provides random access to a cassette tape; something not presently possible with any other computer- or remote-control systems.

### No Programming

What's that?—"How difficult is it to learn to program the Revox software, you ask?" It can be learned in about as much time as it takes you to read a small manual because there is no programming language. You enter the commands—write the script—by simply answering the questions that appear on a menu on the computer screen. It's basically a "big dummy" system, which means you need no technical expertise; it's made for people who know almost nothing about computers.

If you can bring a PC up-and-running, for, say, word processing, you can use the Revox system. In fact, it's harder to program a modern microwave oven to defrost last week's beefstew than it is to program the Revox to record your favorite FM program on Monday evening, at 8 PM.

### Permanence

Since the script is actually a set of commands, it can be saved as a disk file for future use; you don't have to rewrite reusable commands every time. For example, if you want to record, say, a sequence of four FM programs every Wednesday night, you'd simply need to reload the disk file into the computer's memory. It's sort of like extensive VCR time-and-date recording, but with a much higher degree of flexibility.

### Serial Control

The Revox computerized-control system requires a PC having a serial port, a minimum of 256K of RAM, and at least one floppy disk; although two disks make life a bit easier (as it does for most other software). As shown in Fig. 1, a simplified block diagram of the Timer Controller connections, both the individual instruments and the PC connect to the B203 Timer Controller through bi-directional serial ports. Bi-directional means the computer or Timer/Controller can send a command and receive a status report from a specific device via the same port.

There is absolutely nothing spectacular about that type of arrangement other than its simplicity. Instead of using special relay assemblies and cabling, the user simply takes the equipment home and plugs in the matching cable. It's the way personal computers started out before the experts were

called in to create *chaos out of simplicity*.

### Installation

To add a disk drive to an early Radio Shack computer, it was only necessary to purchase the matching drive and cable. You went home, plugged in the cable and everything worked the first time out. There was no such thing as programming jumper DIPs or opening the drive to remove a terminating resistor block. Just plugging in the cable did it all.

Well, it's the same with the Revox system. You open the box, plug in the serial cable, and everything works. That's all there is to it. You don't even need—or get—an 800 telephone number to call in the event that you have any problems, because you won't have any. The Revox B203 system actually does make your PC into an ordinary home appliance.

If you want more info on the system you could write to Revox at 1325 Elm Hill Pike, Nashville, TN 37210, but you get faster results and have more fun if you see, and possibly use the system, at your local Revox dealer. ■

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## POWER LINE FOR TIN LIZZY

(Continued from page 76)



A neon night-light is used for the initial test. Both electrodes of the light should glow with equal brilliance if the inverter is operating correctly. Follow testing instructions in text.

side, the reading will be around 95 volts. With the switch set to 40 watts, the output voltage will be around 110 volts. Most AC devices will operate on voltages from 110 to 125 volts, so with a fully-charged battery you can use either the high 20-watt output or the 40-watt output. As the battery becomes discharged, the 40-watt output may drop below 110 volts, in which case use the high 20-watt output.

With the engine running the input voltage jumps to about



Clip leads can be used instead of the cigarette lighter plug if you want to connect the inverter directly to the battery.

14 volts. The 40-watt output will be about 125 volts. The high 20-watt output will be above 125 volts and the low 20-watt output will be about 110 volts. In that case you can use either the 40-watt setting or the low 20-watt setting. Under certain conditions, the charging system may cause the input voltage to go higher than 14 volts; in that case the 40-watt output may be above 125 volts so only the low 20-watt outlet should be used.

Since even a small voltage drop in the primary-winding circuit will be multiplied into a significant drop in the output of the secondary-winding circuit, you may want to connect the inverter directly to the battery terminals. To do that replace the cigarette lighter plug with a pair of large clips. ■

## E-Z MATH

(Continued from page 83)

In Figure 19B, the source of driving impedance is that of emitter follower Q1 which is approximately  $R1$  divided by the transistor gain  $H_{fe}$  or beta. The input impedance to the FET amplifier Q2 is just  $R2$ .

At the higher frequencies,  $X_C$  is low, so most signals get coupled from stage to stage. But as the signal frequency decreases,  $X_C$  goes up so less and less gets passed to the next stage. The RC values set the low frequency cut-off point for the amplifier. In audio amplifiers, it is usually desirable to pass as wide a range of frequencies as possible. Most humans can hear frequencies down to 20 or 50 Hz. Therefore, the cut-

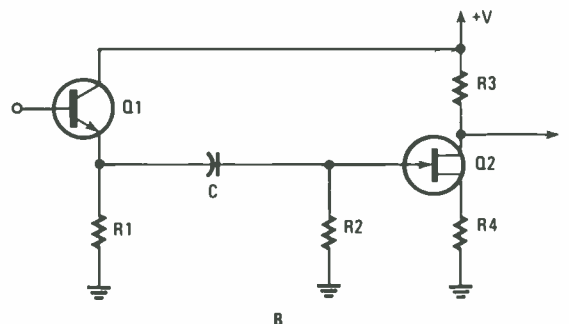
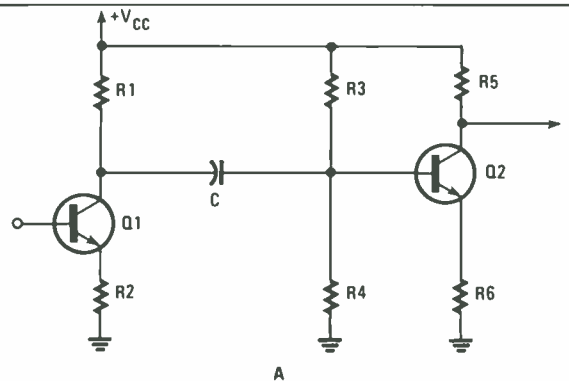


Fig. 19—Proper coupling of amplifiers requires a knowledge of attenuation.

off frequency is normally set down in that range. With the input impedance set by the amplifier design, it is necessary to select a capacitor that will give the desired cut-off. ■



"Sorry, I can't come out to play now Larry . . . I've got to stay in and show my dad how to use our new computer."

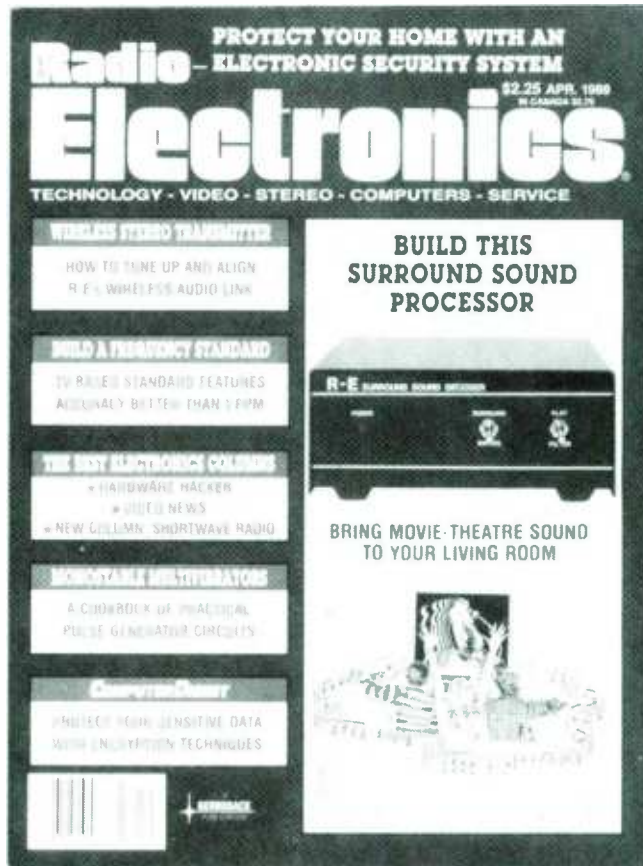


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## ELLIS ON ANTIQUE RADIO

(Continued from page 85)

have to admire his ingenuity in coming up with all of those conversions!

### Coil Correction

I've received several reader letters about the Crosley 50 articles that appeared in the January and February issues, and I think I'll run the letters all together in a future column. But *Vern Reckmeyer* (Boulder, CO) corrected me on a point of general interest that's worth mentioning here. When talking about the Crosley's distinctive RF coils, I wrongly referred to them as *honeycomb* types. They're really *spiderweb* coils, and I'm running illustrations of both kinds (see Fig. 2) to set the record straight!

### Build a Crystal Set

Several readers have requested construction details for a simple crystal set, and I recently received some from *Charles and Irene Porter* (Louisville, KY). The circuit, see Fig. 3, is simplicity itself, but working out the right specifications for the coil took quite a bit of experimentation.

Wind it on a 1 1/2-inch diameter form (perhaps a shellacked mailing tube, or wood dowel) using #22 magnet wire. The primary and secondary are both close-wound (15 turns for the primary and 83 for the secondary), and they are spaced 1/4-inch apart. Bring out a tap from the secondary at 46 turns from the end closest to the primary.

The tuning condenser is a standard broadcast-receiver type (365 pF). If you're salvaging a typical 2-section unit

## NEW PRODUCTS

(Continued from page 15)

time event, such as making an unattended recording. Day of the week and time programming enables repeatable musical events, such as turning on a favorite radio program, playing a cassette or CD at the same time each day.

One-button easy operation in conjunc-

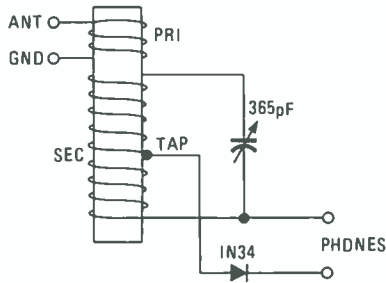


Fig.3—Schematic of reader Porter's simple crystal set (see text for construction details).

from an old set, wire in just one of the sections (the larger one, if they differ in size). The diode used was an IN34, but almost any small-signal type should do. If you can find one, you might even substitute an old-fashioned galena-and-cat's-whisker crystal detector. Finally, be sure you use high-impedance earphones (at least 2000-ohms), not the 8- or 16-ohm kind that are used for hi-fi receivers.

### See You Next Month!

In the meantime, be sure to send your questions and comments to Marc Ellis, C/O Hands-on Electronics, 500-B Bi-County Blvd., Farmingdale, NY 11735.

tion with the B205 remote control is the ultimate in manual operation. It enables the listener to change music sources at the touch of a single button from across the room. Similar one touch operation can also be made directly from any of the Revox components in the audio system.

Suggested retail price for the B203 Timer Controller is \$600. Price for software to be announced. For additional information contact Revox Division, Studer Revox America Inc., 1425 Elm Hill Pike, Nashville, TN 37201; Tel. 615/254-5651.

### Hot Tweezer Removal Unit

Designated the SMT-W2, the OK Industries hot-tweezer SMD (surface-mounted device) removal unit features variable temperature and high reliability at the soldering tips where you need them. The SMT-W2 incorporates an ergonomically designed hand-piece that can be comfortably held by any operator regardless of hand size. Two eight-watt ceramic heating elements provide exceptional temperature stability and sufficient power to remove any SMD currently available, from flea-size chips to large quad packs.



CIRCLE 74 ON FREE INFORMATION CARD

A full range of tips are available including 5-mm tips for resistors or capacitors, mini-flats for SOICs and right angle tips for PLCCs to 84 pins. List price is \$425.00. For more information contact: O.K. Industries Inc., 4 Executive Plaza, Yonkers, NY 10701; Tel. 800/523-0667, in New York State call 914/969-6800.

### RFI-Free Choke Kit

The proven and highly effective solution for eliminating RFI is to wind an offending cable or wire around a ferrite toroid to choke off and eliminate RFI. The problem is finding a toroid with the proper characteristics that has a big enough hole to pass through the end of a power cord or AC adapter or

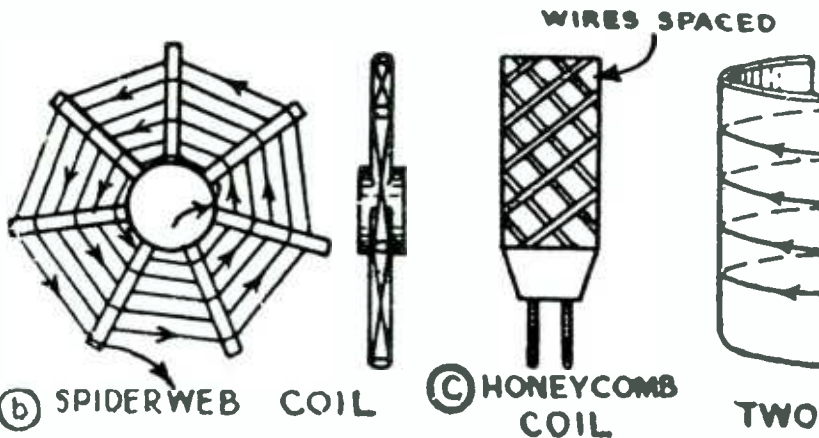


Fig. 2— Illustration copied from old book shows difference between spiderweb and honeycomb coils. Honeycomb unit, shown here in end view only, is cylindrical and has center hole. It is built up of "open-weave" wire layers wound at right angles to each other.



microphone cord or speaker leads, or whatever you have.

The MFJ Enterprises 701 RFI-Free Choke Kit gives you a package of four RFI eliminating toroids with complete instructions. The toroids not only have the right properties for eliminating RFI, but each toroid separates in half. That makes it easy to wind around the toroid nearly any kind of wire or cable. For example, computer ribbon cable, coax cable, or a power cord with an AC adapter on its end can be wound around the toroid easily. The completed toroid halves then mount in a snap-together plastic frame.



CIRCLE 76 ON FREE INFORMATION CARD

The individual toroids also snap together into a stack. That increases effectiveness for large diameter wires when only a few turns can be wound around the toroid. The choke kit sells for \$14.95 retail.

If you would like additional information on the MFJ Enterprises 701 RFI-Free Choke kit contact MFJ Enterprises, Inc. at 921 Louisville Road, Starkville, MS 39759; Tel 800/647-1800 or 601/323-5869.

### PC/Optical Links

Now you can use the magic of light and fiber-optic cables to interconnect PCs. Easy-to-install and simple-to-use PC half-card boards are available with either one or two ports.

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CIRCLE 79 ON FREE INFORMATION CARD

ble and, once such cable is installed, enable transmission at distances of up to 2.5 miles (4 kilometers) and rates to 76.8 Kbps.

For information on these optical links and hundreds of other quality data communications and computer devices contact: Black Box Catalog, P.O. Box 12800, Pittsburgh, PA 15241; Tel. 412/746-5500.

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**H7-88**

## CIRCUIT CIRCUS

(Continued from page 88)

was the case in Fig. 3. The circuits in Fig. 4 and Fig. 5 can be used in conjunction with this circuit, and connects in the manner previously discussed.

It's best to have the input voltage for each of the ten switch positions adjusted to the middle switching range of U1, so that two of the input switch positions won't end up as a single output. To help keep the voltage across each 1000-ohm resistor equal, use 5% or better tolerance units in the divider string.

Connect a voltmeter to pin 15 of U1, set S1 to the *fifth* position and slowly turn R1 until the voltage drops almost to zero. You'll need a resistive load connected between U1's output and the +5-volt bus for the adjustment. There will be a point in the rotation of R1 at which the voltage goes back up. That is no-man's land and the potentiometer should be set in the middle of those two adjustments. Be sure that each of U1's outputs have a pull-up current source (resistive path to the 5-volt bus) and check each of the remaining 9 positions of the switch.

Looks like that about wraps things up for this month. So go forth and do some electronics magic. ■

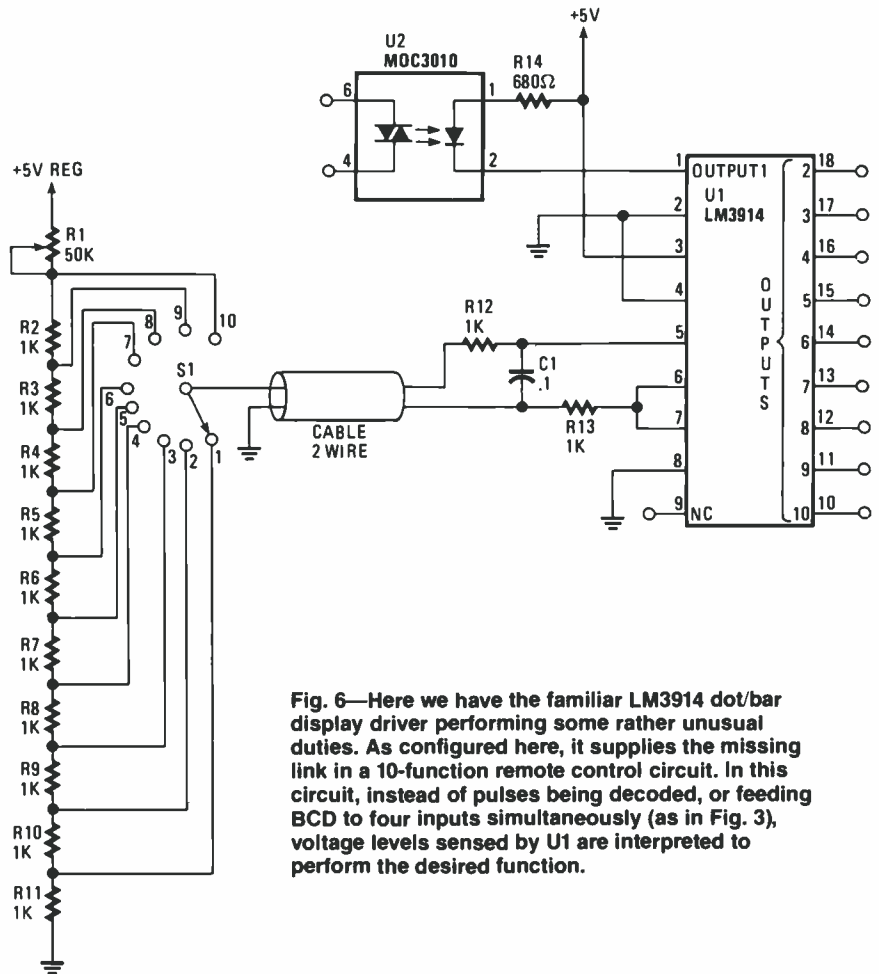


Fig. 6—Here we have the familiar LM3914 dot/bar display driver performing some rather unusual duties. As configured here, it supplies the missing link in a 10-function remote control circuit. In this circuit, instead of pulses being decoded, or feeding BCD to four inputs simultaneously (as in Fig. 3), voltage levels sensed by U1 are interpreted to perform the desired function.

## BUILD THE BVM

(Continued from page 70)

The author's prototype of the BVM was built on perfboard using point-to-point wiring to complete both signal and power connections, via color-coded wires.

connection must be the equipment side of the on/off switch to prevent current drain with the equipment off.

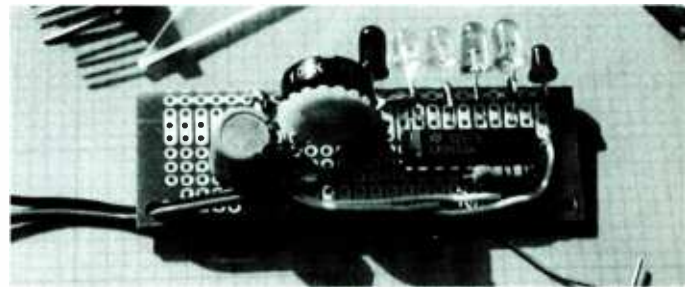
If the battery monitor is to be internally mounted in the equipment, a rectangular window or a series of holes must be drilled through which the LEDs will protrude. If space is limited for internal mounting, the overall size of the BVM may be reduced by using a horizontally mounted 100,000-ohm potentiometer instead of the vertically-mounted one.

### Troubleshooting the BVM

If the 100,000-ohm potentiometer does not vary the voltage at pin 5, check: for an open, unconnected or incorrectly connected Zener. Also check for shorts between pins 4 and 5.

If the LEDs do not light at any applied voltage, check: for the presence of voltage on the LED bus line; the orientation of the LEDs; and the connections to the 100,000-ohm potentiometer.

If, ten NiCad cells do not charge or indicate 12.0 volts: check the individual NiCad cells for 1.2 volts. If any NiCad cell shows less than 0.05 volts after normal charge time, momentarily apply 12 volts across cell and recheck voltage. If voltage measures 1.0 to 1.3 volts, discharge all 10, cells and recharge normally. If during charging, NiCad batteries be-



come warm to hot, stop charge immediately and allow to cool. Start recharge when cool after inserting a 100-ohm resistor in series with positive charge line. (Vary that resistance between 100 and 470 ohms to obtain proper charging current.) ■





## OFF-AIR KEYING MONITOR

(Continued from page 46)

both sides of the board; the circuit doesn't care which side of the board contains the parts. However, try to keep all the transistors on one side so that you are certain of there will be sufficient clearance to the cabinet when the board is installed.

### Maximum Sensitivity

As for the solid-state components, for maximum sensitivity to pipsqueak RF signals, diode D1 and transistors Q1 and Q2 should be the germanium type because germanium has a lower barrier (breakover) voltage than silicon; which in non-technical terms means it takes a lower voltage to make them conduct. Transistors Q1 and Q2 can be any PNP type having a gain (beta) of about 50–200 that is suitable for switching, such as the 2N404A. (You must have a stack of those lying around from "the good old days.")

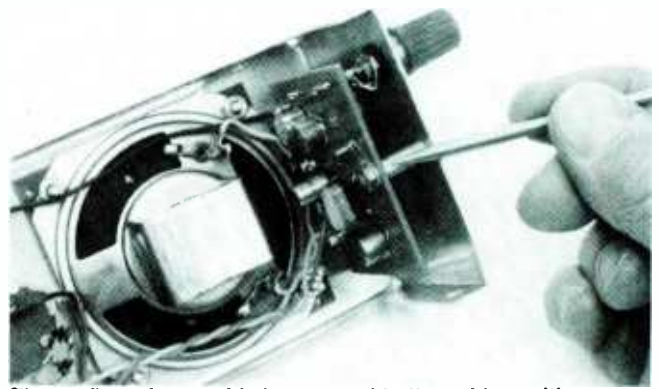
Transistor Q3 is any PNP transistor with a gain of 150 or more—the higher the better. As you can see from the Parts List, even the germanium 2N2613—another oldie—will work. Transistor Q4 can be any NPN type with a gain of 50 or more. We found an old Motorola HEP 53 in the junkbox of the local parts emporium and it worked well. So did any other germanium or silicon NPN transistor.

Speaker SPKR1 can be anything having an impedance of approximately 8–10 ohms. The one shown in the photographs was salvaged from a 20-year-old *el cheapo* pocket radio: the kind that were given away by banks as gifts for opening an account.

Tone control R2 can be any kind of potentiometer. Switch S1 can be part of R2 or a separate switch. Use whatever you have lying around; the object is not to spend money.

### Final Assembly

While the final assembly isn't necessarily critical, try to follow the layout shown, because if RF "gets loose" inside the cabinet it can result in a high-pitched, very low, but continuous background tone.



The perfboard assembly is mounted to the cabinet with a single screw and nut. The pointer indicates the spacer that keeps the board off the cabinet so the wiring on the underside of the board can't short to the cabinet.

Locate the position for binding post BPI and drill its mounting hole before installing any components in the cabinet. BPI's solder lug should be positioned directly opposite the input to D1 so the antenna connection can be made by simply bending BPI's lug down against the *flea clip* that supports D1. For protection, simply place a piece of perfboard or screening between the speaker and the cabinet. Use some kind of holder for battery B1.

### Using the Monitor

If you have a high-power transmitter, a short length of solid wire about a foot long connected to BPI will probably pick up enough RF to trigger the monitor. If your transmitter is QRP (very low power), it's more than likely you'll have to run a short wire from BPI and wrap the free end around the transmitter's antenna connector or the transmission line.

Although the monitor's volume level has been preset to a low, but comfortable, average level, the pitch of the output tone can be adjusted with R2. Suit it to your needs and enjoy using CW communication to its fullest. ■

## AQUISENSE

(Continued from page 62)

While D-cells are more economical in the long run, they might be physically too large for some enclosures. The normal current requirement of the circuit is just over 2mA. A single 9-volt alkaline battery can be used if short battery life is acceptable.

Referring to the photo of the author's prototype, notice the screw-type terminal strip with 4 terminals on the front panel. Those terminals are divided up electrically into two sets (each set having 2 terminals) and connected in parallel. Refer to the schematic in Fig. 1 for details. The screw-type terminal has three purposes. SEN1 is connected to the terminal, as is the optional wetness sensor SEN2. Also, the terminal provides a battery/circuit check.

To check the battery/circuit, simply touch two terminals with a wet finger. If the circuit is operating correctly, the buzzer should sound off. If it does, close up the enclosure and breath a little easier. ■

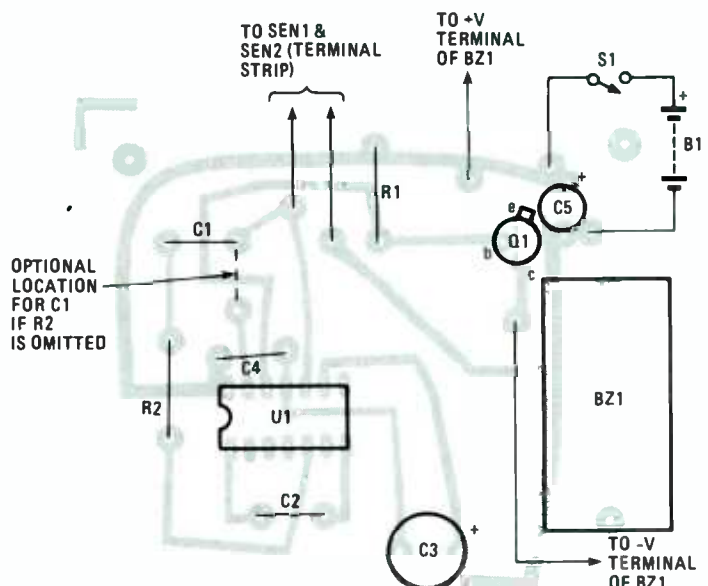


Fig. 5—Using this parts placement diagram as a guide, the Aquisense should be a snap to put together. If you do not use R2, C1 is connected between pin 10 and pin 13 of U1.

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## SAXON ON SCANNERS

(Continued from page 91)

on one frequency and the mobile units transmit on a second frequency several MHz away from the dispatcher's frequency. For monitoring an ordinary duplex system, two frequencies must be programmed into your scanner. Once again, your ability to monitor distant mobile transmissions will be somewhat limited.

Some duplex systems use a device known as a repeater. That is, when the base station receives a transmission from a mobile unit, the mobile transmission is rebroadcast simultaneously on the base station's frequency via the dispatcher's more-powerful equipment and higher, more-efficient antenna system. Repeaters are used in order to make possible reception of mobile unit transmissions by other mobile units, which are hampered (like the scanner listener) in receiving a weak signal from another mobile unit.

Obviously, duplex systems with repeaters are an advantage to the scanner listener, who will be able to clearly receive both sides of the conversation by monitoring only one channel (the one used by the base station dispatcher). While repeaters are often used in the 150 to 174 MHz band, the majority of systems operating in the 450 to 512 MHz UHF band use that type of arrangement.

Once you have a basic understanding of the various types of communications systems, you should be able to see why there's such a wide variation in your scanner's ability to hear the mobile unit's side of a communications exchange.

All telephone-related systems, including CMT's, cordless phones, and even ship-to-shore telephones are variations on the repeater/duplex theme, although some of those systems are more sophisticated than others. Car telephones are the most sophisticated, with ship-to-shore being rather humble by comparison. Car telephones permit normal conversational exchanges, but in ship-to-shore communications, only one party at a time can talk and must then say "over" to let the other person know when they can speak.

We welcome your letters, comments, questions, frequency lists, and even photos of your station. Write to Marc Saxon, *Saxon on Scanners*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

## SOLDERING GUN

(Continued from page 68)

quired. An ultra-fine tip, the 1205, uses 20-watts of power and is ideal for printed-circuit board and micro-electronics applications.

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The Ungar 1200 Rechargeable and the Ungar 2200 Rechargeable Soldering Kit are available through electronics distributors. For further information,

contact Ungar, Division of Eldon Industries, Inc., 100 West Manville Street, Compton, CA 90220; (Tel. 213/774-5950; or Eldon Industries of Canada, Inc., 500 Esna Park Drive, Markham, Ontario, Canada, L3R-1H5; Tel. 415/475-9407). A leader in professional soldering since 1935, Ungar offers soldering and de-soldering equipment, heat guns and related items. For more information on the Ungar 1200 and 2200 products circle number 83 on the Free Information Card. ■

## BUILD THE SUPER BREADBOARD

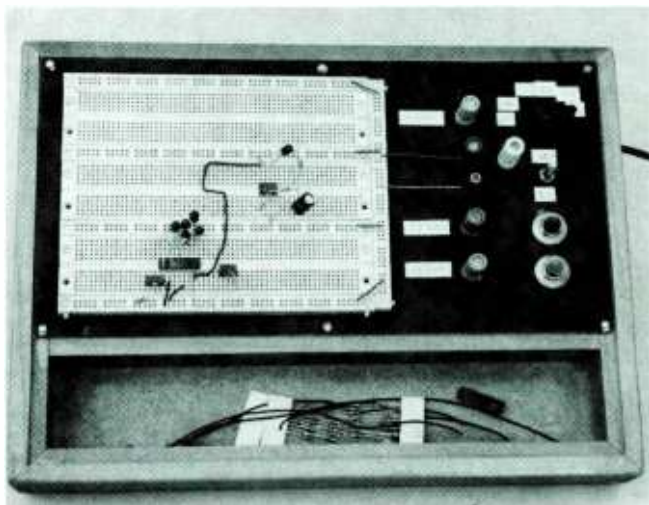
(Continued from page 33)

The parts layout for the PC board is shown in Fig. 3. The PC board is mounted under the baseboard on three threaded standoffs. The standoffs are mounted using flat-head screws from the top of the baseboard. The screw heads are countersunk so they won't interfere with the bread boards on top. That allows you to remove the PC board for modification or troubleshooting without disturbing the bread boards after they are mounted.

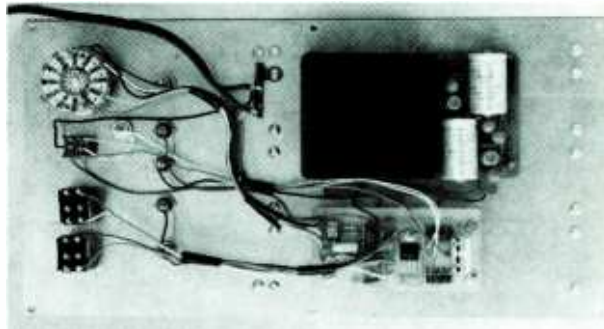
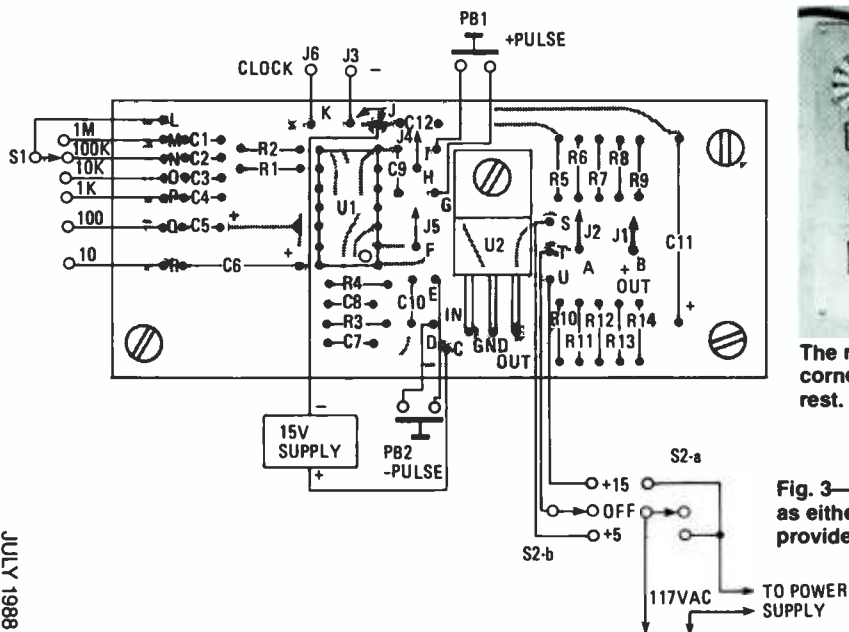
The power supply is also mounted against the bottom of the baseboard with countersunk flat-head screws through from the top of the base board. The bread board strips are arranged in the pattern desired on the top of the base board, and attached with 6-32 x 3/8-in. long screws from the bottom.

The baseboard is mounted in a wood frame as high as required by the power supply chosen. By making the frame a few inches wider than the actual base board, you have a compartment that can be used to store your jumper wires. That will keep the jumpers from being lost, and they will always be with the board with which they will be used. Since the layout is quite flexible, and depends only on the parts used and the individual requirements of the builder, no actual dimensions are shown for the switches and jacks on the panel. They will depend on the bread boards chosen and outlets required on your own layout.

After you design and build your Super Breadboard, you will discover how much easier it is when your breadboard contains all the features found in the most expensive commercial units. You can launch your new circuit ideas with a lot less effort and cable clutter. 3...2...1...Take off! ■



Building the cabinet with an area for small wires is a great idea and comes strongly recommended. The switch for power-supply voltage selection used by the author locks into position to avoid accidentally blowing a 5-volt circuit with a surge of 15-volt electricity, and is also recommended.



The ready-made power supply is in the upper right-hand corner of this photo and provides 15 volts to drive the rest. The small board generates pulses and 5-volts.

Fig. 3—When using the pc foil pattern, you can mount C5 as either a radial or axial type since two solder pads are provided for it. It is shown here connected as a radial type.



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# EIA/CEG ANNOUNCES COMPLETION OF NEW "BASIC CAR AUDIO INSTALLATION" VIDEO TAPE

If you are thinking of "cashing in" on the profits in the ever growing car audio service business, the troubleshooting—service—installation—and removal of car audio products is a large, non-competitive profit center for your service facility. This thirty minute video introduces you to the ever increasing complex world of car stereo installation. It guides the new installer or owner in the correct layout and design of a car stereo installa-

tion facility, covering basic as well as specialized tools needed for the installation business.

This informative videotape is also an excellent aid to the electronics technician in that it gives the correct procedure for removing and replacing "any" car radio from the dashboard of any car and shows the installer's, salesperson's and customer's role in the installation and sale of car audio products.

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- Basic and specialized tools needed for car audio installation work.
- Safety in the shop.
- How to treat the customer's car, from pre-installation checkout to demonstrating to the customer the completed job.
- The proper procedure



for installing car audio equipment.

- The technical resources available for information about specific types of vehicles, dashboard dismantling, speaker sizes and antenna locations.
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**The cost of the videocassette is \$30.00. Use the order form below to order yours now!**

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