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INTEGRATED CIRCUITS

7400 TTL

Part	Price
7400N	.43
7401N	.43
7402N	.43
7403N	.43
7404N	.46
7405N	.46
7406N	.60
7407N	.60
7408N	.45
7409N	.43
7410N	.43
7411N	.43
7412N	.60
7413N	.60
7414N	.99
7416N	.49
7417N	.49
7420N	.43
7421N	.60
7425N	.52
7426N	.49
7427N	.49
7428N	.60
7430N	.43
7432N	.43
7437N	.49
7438N	.49
7440N	.49
7441AN	1.38
7442N	.58
7445N	1.00
7446N	1.00
7447N	1.25
7450N	.43
7451N	.49
7453N	.43
7454N	.43
7460N	.43
7470N	.60
7472N	.60
7473N	.60
7474N	.60
7475N	.58
7476N	.56
7480N	.79
7482N	.52
7483N	.87
7485N	.70
7486N	.67
7489N	.87
7490N	.70
7491N	.87
7492N	.70
7493N	.70
7495N	.70
7496N	.70
7497N	3.00

74S00 TTL

Part	Price
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74S02N	.46
74S03N	.46
74S04N	.61
74S05N	.46
74S08N	.46
74S10N	.46
74S11N	.46
74S20N	.46
74S22N	.46
74S32N	.46
74S37N	.46
74S38N	.46
74S40N	.46
74S51N	.46
74S64N	.46
74S74N	.46
74S86N	.46
74S112N	.46
74S113N	.46
74S114N	.46
74S133N	.52
74S134N	.52
74S138N	.52
74S139N	.52
74S140N	1.12
74S151N	.87
74S153N	.87
74S157N	.87
74S158N	.87
74S174N	.87
74S175N	.87
74S181N	1.70
74S182N	2.50
74S188AN	1.70
74S189N	3.50
74S194N	.87
74S195N	.87
74S196N	.87
74S240N	1.25
74S241N	1.25
74S243N	3.50
74S244N	1.25
74S251N	1.08
74S253N	1.08
74S257N	1.08
74S258N	1.08
74S260N	.87
74S273N	3.50
74S274N	3.50
74S275N	3.50
74S280N	.87
74S287N	4.60
74S288N	4.60
74S289N	4.60
74S299N	3.50
74S373N	2.00
74S374N	2.00
74S387N	4.60
74S471N	3.50
74S472N	4.60
74S473N	4.60
74S474N	2.00
74S475N	3.75
74S571N	3.75
74S572N	4.60
74S573N	3.75
74S574N	4.60
74S575N	3.75
74S576N	4.60
74S577N	3.75
74S578N	4.60
74S579N	3.75
74S580N	4.60
74S581N	3.75
74S582N	4.60
74S583N	3.75
74S585N	4.60
74S588N	4.60
74S589N	2.50

74LS00 TTL

Part	Price
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74LS01N	.52
74LS02N	.39
74LS03N	.39
74LS04N	.39
74LS05N	.39
74LS08N	.39
74LS09N	.39
74LS10N	.39
74LS11N	.39
74LS12N	.39
74LS13N	.63
74LS14N	.99
74LS15N	.39
74LS20N	.39
74LS21N	.39
74LS22N	.39
74LS26N	.39
74LS27N	.39
74LS28N	.39
74LS30N	.39
74LS32N	.39
74LS33N	.39
74LS37N	.39
74LS38N	.39
74LS40N	.39
74LS42N	.99
74LS47N	1.44
74LS48N	1.44
74LS51N	.39
74LS54N	.39
74LS55N	.39
74LS73N	.52
74LS74N	.52
74LS75N	.63
74LS76N	.52
74LS78N	.52
74LS83N	1.44
74LS85N	1.44
74LS86N	.52
74LS90N	.63
74LS92N	1.44
74LS93N	.63
74LS95N	1.44
74LS96N	1.44
74LS107N	.52
74LS109N	.52
74LS112N	.52
74LS113N	.52
74LS114N	.52
74LS122N	.68
74LS123N	.99
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74LS133N	.63
74LS136N	.63
74LS138N	.63
74LS139N	.63
74LS145N	1.44
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74LS148N	1.44
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74LS153N	.63
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74LS156N	.63
74LS157N	.63
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74LS162N	1.01
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74LS165N	1.01
74LS166N	1.44
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74LS247N	1.44
74LS248N	1.44
74LS251N	.79
74LS253N	.79
74LS257N	.63
74LS258N	.63
74LS259N	1.44
74LS260N	.63
74LS266N	.63
74LS273N	1.44
74LS279N	.79
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74LS283N	1.44
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74LS293N	1.04
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74LS367N	.63
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74LS377N	1.44
74LS378N	1.44
74LS379N	1.44
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74LS387N	.79
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74LS653N	1.44
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74LS669N	1.44
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74LS697N	3.50
74LS698N	3.50
74LS699N	3.50

74HC00 CMOS

Part	Price
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74HC11N	.30
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74HC20N	.30
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74HC30N	.30
74HC32N	.30
74HC42N	.87
74HC51N	.30
74HC73N	.73
74HC74N	.73
74HC75N	.73
74HC76N	.60
74HC85N	.87
74HC86N	.60
74HC107N	.73
74HC109N	.73
74HC112N	.73
74HC123N	1.00
74HC125N	.66
74HC126N	.66
74HC132N	.87
74HC133N	.66
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74HC266N	1.12
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74HC378N	1.44
74HC379N	1.44
74HC381N	3.50
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74HC653N	1.44
74HC668N	1.44
74HC669N	1.44
74HC670N	1.44
74HC673N	3.50
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74HC675N	3.50
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74HC697N	3.50
74HC698N	3.50
74HC699N	3.50

Linear

Part	Price
LF347N	1.62
LF351N	.94
LF353N	1.62
LF356N	1.62
LF357N	1.62
LF398N	9.00
LF411CN	2.50
LF412CN	3.50
LM301AN	.67
LM308N	1.62
LM309K	1.62
LM311N	.87
LM312N	1.62
LM317T	1.62
LM318N	1.62
LM320LZ 5 V	.80
LM320LZ 12	.80
LM320LZ 15	.80
LM320MP 5	1.87
LM320MP 12	1.87
LM320MP 15	1.87
LM324N	.87
LM331N	5.25
LM334Z	1.12
LM335Z	2.95
LM336Z 2.5	1.25
LM336Z 5	1.25
LM337T	3.62
LM338K	8.50
LM339N	.87
LM340K-5, 12, 15	1.62
LM340K-18, 24	1.62
LM340T-5, 12, 15	1.25
LM340T-18, 24	1.25
LM348N	1.62
LM350K	8.50
LM350T	3.62
LM358N	.45
LM359N	2.00
LM377N	3.00
LM380N	.87
LM380N-8	1.38
LM381N	2.17
LM382N	2.17
LM383A	3.27
LM384N	2.17
LM386N-1, -3	.87
LM386N-4	1.37
LM387N	1.37
LM388N	1.37
LM389N	1.15
LM390N	2.17
LM391N-80	2.00
LM391N-100	2.00
LM392P	1.62
LM393N	.45
LM394N	3.50
LM399H	6.00
LM3900N	.87
LM3905N	1.62
LM3909N	1.15
LM3911N	1.62
LM4250CN	2.50
LM4558N	.45
LM4562N	1.62
LM4565N	1.62
LM4700N	2.50
LM4702N	2.50
LM4711N	2.50
LM4712N	2.50
LM4741CN	.67
LM4742CN	1.62
LM4744CN	1.62
LM4746CN	1.62
LM4747CN	2.50
LM4748CN	.67
LM4749CN	1.62
LM4751N	2.50
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LM4753N	2.50
LM4756CN	1.62
LM4757CN	2.50
LM4758CN	1.62
LM4759CN	2.50
LM4760CN	1.62
LM4761CN	2.50
LM4762CN	1.62
LM4763CN	2.50
LM4766CN	1.62
LM4767CN	2.50
LM4768CN	1.62
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LM4770CN	1.62
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LM4797CN	2.50
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LM4799CN	2.50
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Volume 5, No. 10

OCTOBER 1988

CONSTRUCTION

30 **Computer Speech Synthesizer**—give your computer the gift of gab
35 **Solid-State Tesla Coil**—build this solid-state version of Tesla's most-famous experiment
41 **BC Antenna Coupler**—lock in those distant stations with an external antenna
42 **Towers of Power**—get the speakers you want without havng to second guess the manufacturer
82 **Magnetic Jumping Beans**—your friends and family will get a kick out of watching these little fellows do their tricks

FEATURES

17 **The Gravity of Things**—gravity may not be the constant that everyone thinks it is.
59 **Of Mice, and More**—look at what's available in pointing devices
66 **Identifying Defective Motors**—pull those old tape decks and turntables out of the closet and put them back on track
73 **E-Z Math**—Network Analysis: learn the right way to analyze electronic circuits

HANDS-ON REPORTS

26 **Avocado Computer Grayscaler**—get crisp, composite monochrome, with 16 brightness levels, from your CGA card
63 **Digital Voice Recorder**—an adaptable modular kit puts computer-age gadgetry on your workbench

SPECIAL COLUMNS

84 **Ellis on Antique Radio**—a little housekeeping prevents a whole lot of troubleshooting
86 **Friedman on Computers**—a dual-purpose device backs up floppies and provides IBM/Macintosh compatibility
88 **Saxon on Scanners**—get nine-band coverage and 16-channel programmability from a handheld scanner
92 **Jensen on DXing**—pioneer shortwave program celebrates its 60th birthday
94 **Carr on Ham Radio**—ham radio joins forces with computers to improve the communications hobby
96 **Circuit Circus**—electronic pest controllers take some of the drudgery out of maintaining your home

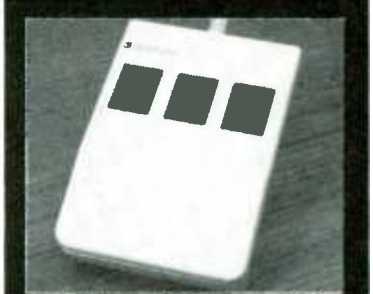
DEPARTMENTS

2 **Editorial**—change is inevitable
4 **Letter Box**—the place to let yourself be heard
12 **Electronics Library**—spotlighting a knowledge storehouse
18 **New Products Showcase**—trends in the electronics marketplace
37 **FactCards**—a fingertip reference for the electronics hobbyist
47 **GIZMO Special Section**—what's new in electronic doo-dads
71 **Free Information Card**—when in doubt, sound the manufacturer out

Speech Synthesizer—page 30

Solid-State Tesla Coil—page 35

Towers of Power—page 42



Of Mice, and More—page 59

Locating Defective Motors—page 66

Hands-on Electronics®

The Magazine for the Electronics Activist!

Change is Inevitable

Letters from our readers tell us to never change our editorial format. What they see in our magazine and what it does for them is, more often than not, exactly what they want. Of course, we love to hear things like that; compliments are always welcome. But we like to hear your criticisms, too. It's your input that makes it possible for the editors here to do their jobs properly.

When transistors first hit the hobby marketplace, many editors hopped on the bandwagon. They were right. When integrated circuits appeared, some editors were fast to promote their applications in hobby areas, others were slow.

The arrival of computers threw the electronics-magazine field into turmoil. Computers are hardly a new topic (even I wrote an article on a basic computer project back in 1961), but in recent years that subject area overwhelmed the editorial balance of many hobby-oriented electronics magazines. Too many of those magazines dedicated 100% of their content to computer-related topics, and many new all-computer magazines were born.

I could understand the introduction of new magazines that were devoted exclusively to computers. What I could not understand was how or why already established hobby-electronics magazines would tie their future success to one area of electronics. To me, it was a calamity to see loyal readers who were interested in other areas of electronics so callously ignored and dropped by magazine publishers.

Of course, if a magazine is to grow with its readers, change is inevitable. Because of that, you can expect some change, be it ever so slight, in almost every issue of **Hands-on Electronics**. But our readers will never be discarded for a keyboard and floppy-drive combo, or anything else for that matter.

Now, you may ask, what's the change for this issue? It's a slight one, to be sure, and one that might not be noticed by many of our readers. See if you can find it!

Next issue, I will make another change, and I'll put that one right on the front cover! Remember, change is inevitable.

Julian S. Martin, KA2GUN
Editor

STAFF

Volume 5, No. 10
October 1988

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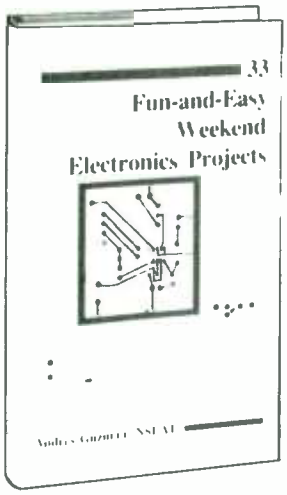

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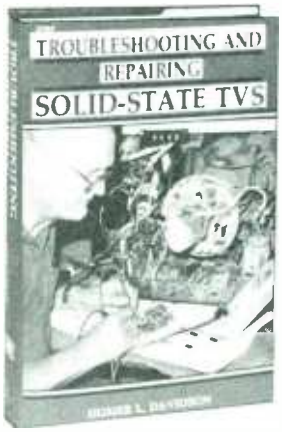

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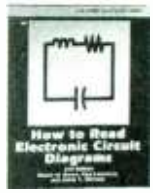

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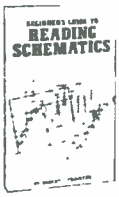

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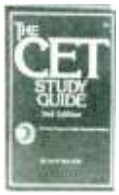

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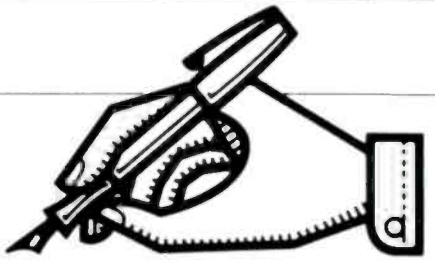

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No Dogs Allowed

Do you have a circuit for an ultrasonic-emission dog repeller? I'm interested in the frequencies and components used. In particular, I need a suitable "speaker," with enough power at those frequencies.
—W.P., Wichita, KS

What a timely question! See this month's "Circuit Circus" for some circuits that might be just what you are looking for.

Tuned Out

I live in the hills of Southern California, where the terrain is good for deterring smog, but terrible for FM-radio signals.

I bought a signal enhancer, but I wasn't pleased with its performance. The main problem was that it couldn't be tuned. It would enhance a strong signal if I was slightly off frequency, but it wouldn't necessarily enhance the frequency I wanted. It only enhanced the strongest signal.

My electronics teacher (who's the one who suggested I subscribe to **Hands-on Electronics**) told me that there isn't a signal to amplify. I hope he meant it isn't worth the trouble.

Do you have a schematic and a parts list for a tunable high-gain RF-amplifier system for my car radio?
—R.W.N., Canyon Country, CA

He could be right. If the signal strength is too low in your area, no amount of enhancement will help—with no signal there's nothing to enhance.

However, before we dismiss the question, there are a few points that should be considered. The characteristic that gives FM reception its interference-free performance is called "capture effect." In essence, if there are two competing signals in a receiver's passband, the receiver will lock onto, or capture, the strongest one. That's why your enhancer isn't doing the job you thought it would: It is enhancing both the strong and weak signal equally, and your receiver is still locking onto the strongest one.

If the distant station you are interested in shares its frequency allocation with the local one, you're out of luck. But if your receiver is poorly designed and has an abnormally wide passband, an outboard tunable filter may help. But, while such filters are available for other bands (shortwave, ham, AM broadcast, etc.), we don't have a circuit that's suitable for use in the FM-broadcast band in our library.

Perhaps one of our readers can help with this. If you have a circuit that will do the job, send it along; we'll publish it in a future issue.

Old Issues For New Reader

The July 1988 issue of **Hands-on Electronics** was the first one I've read. In the "Letter Box," one of the answers referred to a previous issue concerning shortwave radios. I'm new to the radio-frequency field, and I'd like to learn more about it. How can I order that issue?

It seems that some people out there are having problems assembling the projects in your magazine. It could be a communications problem between the authors and the editors. I would like to suggest that you keep the explanations simple, and don't use any abbreviations.

A project I'd like to see is an emergency-ignition system, for cars with electronic ignitions—commonly known as a "hot box." I'm looking forward to future articles.
—T.S., Brooklyn, NY

Back issues of **Hands-on Electronics**, *and more, are available from the Reprint Bookstore. See the ordering coupon on page 102 for more information.*

Buzzing About CPM

I am writing about "fear of computers." Some of us are not *afraid* of computers. We're madder than a bumblebee at how low you and other magazines have made us feel about our old CPM computers.

Long, long ago, you were all pushing those CPM computers. Now that DOS has come along, you've forgotten the old CPM users. Why should you, when we paid just as much for our CPM computers?
—S.P., Hayward, CA

I no longer drive my 1964 Rambler. I must admit that I miss it, but the wheels I have today are more to my liking. I like air conditioning. I like power windows. I like the goodies of today.

By the same token, I miss my old H89 Heathkit computer, but the current generation of MS-DOS machines, and the new PS/2 machines, are clearly superior; it seems that the majority of computer users agree. We haven't forgotten, it's just time to move on.

Crossed Channels

The output channel on my cable-TV converter is Channel 3, but my television set automatically goes to Channel 2 every time it's turned on. When I turn on the box by remote, the TV goes to the wrong channel, and I have to get up to adjust it.

I need an RF modulator to put in circuit with the cable box, or one that goes in line with the box and the TV. I've seen them for Channels 3 and 4, but never for Channel 2. Do you know where I could buy one, or how I could build one?
—M.S., Apple Valley, MN

Most TV sets, including the newer, electronically tuned ones, have a fine-tuning control. Adjust that so that Channel 3 is received at the Channel 2 position.

Public Servants, Not Public Enemies

In "Saxon on Scanners" (**Hands-on Electronics**, August 1988) it says that, according to one state's laws, ". . . nobody except licensed hams can have a mobile receiver that is capable of receiving frequencies used by police agencies"—yet that state doesn't explain why hams would have any more reason to monitor police transmissions than anyone else. As a ham, I'll offer some enlightenment to anyone who may be wondering about that.

"I could have sworn this turkey stole a radio on his way out!"

While most law-enforcement agencies now use the UHF bands for their routine communications, some local and regional public-service agencies continue to plug along in the VHF spectrum (the 150-MHz through the 170-MHz bands.) One of the most heavily populated ham bands, the 2-meter band, resides just below those VHF public-service frequencies, at 144 MHz to 148 MHz.

Recognizing the broader appeal of expanded-frequency coverage, many amateur-radio manufacturers are now selling 2-meter mobile transceivers that receive from approximately 138 MHz to 175 MHz. Transmission, of course, is restricted to the 2-meter band as required by FCC regulations.

With the "no police scanners in vehicles" laws, the installation of an expanded-frequency 2-meter transceiver in a vehicle became, potentially, a *de facto* crime. However, the mish-mash of conflicting laws and ordinances are mostly unenforceable—to the benefit of hams and the community in general, in my area at least.

The Amateur Radio Emergency Service (ARES) group in Santa Barbara works in close harmony with numerous local, regional, state, and national emergency- and disaster-service agencies. Scanning those services' VHF frequencies in our vehicles alerts ARES members to events for which our special emergency-communication services may be requested. In many instances, monitoring those frequencies has helped us gain valuable lead time as we gear up in anticipation of the official "Emergency Callout" that is usually initiated by the Santa Barbara County Sheriff's Office.

We hams have those transceivers, we use them, and it is highly unlikely that we will stop using them due to indistinct and ill-directed politics.

I enjoy "Saxon on Scanners," as I do the entire magazine. **Hands-on Electronics** gets a good reading every month, then passes on to others who enjoy it at least as much as I do.

—W.G.H., Santa Barbara, CA

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8237-5	4.75	8279	2.49
8243	1.95	8279-5	2.95
8250	6.95	8282	3.95
8251	1.29	8283	3.95
8251A	1.69	8284	2.25
8253	1.59	8286	3.95
8253-5	1.95	8287	3.95
8255	1.49	8288	4.95

MATH COPROCESSORS

8087	5 MHz	$99.95
8087-2	8 MHz	$159.95
8087-1	10 MHz	$229.95
80287	6 MHz	$179.95
80287-8	8 MHz	$249.95
80287-10	10 MHz	$309.95
80387-16	16 MHz	$499.95
80387-20	20 MHz	$799.95

intel®

74LS00

74LS00	.16	74LS112	.29	74LS241	.69
74LS01	.18	74LS122	.45	74LS242	.69
74LS02	.17	74LS123	.49	74LS243	.69
74LS03	.18	74LS124	2.75	74LS244	.69
74LS04	.16	74LS125	.39	74LS245	.79
74LS05	.18	74LS126	.39	74LS251	.49
74LS08	.18	74LS132	.39	74LS253	.49
74LS09	.18	74LS133	.49	74LS257	.39
74LS10	.16	74LS136	.39	74LS258	.49
74LS11	.22	74LS138	.39	74LS259	1.29
74LS12	.22	74LS139	.39	74LS260	.49
74LS13	.26	74LS145	.99	74LS266	.39
74LS14	.39	74LS147	.99	74LS273	.79
74LS15	.26	74LS148	.99	74LS279	.39
74LS20	.17	74LS151	.39	74LS280	1.98
74LS21	.22	74LS153	.39	74LS283	.59
74LS22	.22	74LS154	1.49	74LS290	.89
74LS27	.23	74LS155	.59	74LS293	.89
74LS28	.26	74LS156	.49	74LS299	1.49
74LS30	.17	74LS157	.35	74LS322	3.95
74LS32	.18	74LS158	.29	74LS323	2.49
74LS33	.28	74LS160	.29	74LS365	.39
74LS37	.26	74LS161	.39	74LS367	.39
74LS38	.26	74LS162	.49	74LS368	.39
74LS42	.39	74LS163	.39	74LS373	.79
74LS47	.75	74LS164	.49	74LS374	.79
74LS48	.85	74LS165	.65	74LS375	.95
74LS51	.17	74LS166	.95	74LS377	.79
74LS73	.29	74LS169	.95	74LS390	1.19
74LS74	.24	74LS173	.49	74LS393	.79
74LS75	.29	74LS174	.39	74LS541	1.49
74LS76	.29	74LS175	.39	74LS624	1.95
74LS83	.49	74LS191	.49	74LS640	.99
74LS85	.49	74LS192	.69	74LS645	.99
74LS86	.22	74LS193	.69	74LS670	.89
74LS90	.39	74LS194	.69	74LS682	3.20
74LS92	.49	74LS195	.69	74LS688	2.40
74LS93	.39	74LS196	.59	74LS783	22.95
74LS95	.49	74LS197	.59	25LS2521	2.80
74LS107	.34	74LS221	.59	26LS31	1.95
74LS109	.36	74LS240	.69	26LS32	1.95

7400

7400	.19	7474	.33
7402	.19	7475	.45
7404	.19	7476	.35
7406	.29	7483	.50
7407	.29	7485	.59
7408	.24	7486	.35
7410	.19	7489	2.15
7411	.25	7490	.39
7414	.49	7493	.35
7416	.25	74121	.29
7417	.25	74123	.49
7420	.19	74125	.45
7430	.19	74150	1.35
7432	.29	74151	.55
7438	.29	74153	.55
7442	.49	74154	1.49
7445	.69	74157	.55
7447	.89	74159	1.65
7473	.34	74161	.69
		74164	.85
		74166	1.00
		74175	.89
		74367	.65

LINEAR

TL071	.69	LM567	.79
TL072	1.09	NE570	2.95
TL074	1.95	NE592	.98
TL082	.99	LM723	.49
TL084	1.49	LM733	.98
LM301	.34	LM741	.29
LM309K	1.25	LM747	.69
LM311	.59	MC1330	1.69
LM311H	.89	MC1350	1.19
LM317K	3.49	LM1458	.35
LM317T	.69	LM1488	.49
LM318	1.49	LM1489	.49
LM319	1.25	LM1496	.85
LM320	see 7900	ULN2003	.79
LM323K	3.49	XR2206	3.95
LM324	.34	XR2211	2.95
LM331	3.95	LM2917	1.95
LM334	1.19	CA3046	.89
LM335	1.79	CA3146	1.29
LM336	1.75	MC3373	1.29
LM338K	4.49	MC3470	1.95
LM339	.59	MC3480	8.95
LM340	see 7800	MC3487	2.95
LF353	.59	LM3900	.49
LF356	.99	LM3911	2.25
LF357	.99	LM3909	.98
LM358	.59	LM3914	1.89
LM380	.89	MC4024	3.49
LM383	1.95	MC4044	3.99
LM386	.89	RC4136	1.25
LM393	.45	RC4558	.69
LM394H	5.95	LM13600	1.49
TL494	4.20	75107	1.49
TL497	3.25	75110	1.95
NE555	.29	75150	1.95
NE556	.49	75154	1.95
NE558	.79	75188	1.25
NE564	1.95	75189	1.25
LM565	.95	75451	.39
LM566	1.49	75452	.39
NE590	2.50	75477	1.29

H TO-5 CAN, K TO-3, T TO-220

6500

1.0 MHz

6502	2.25		
65C02	(CMOS) 7.95		
6520	1.65		
6522	2.95		
6526	13.95		
6532	5.95		
6545	2.95		
6551	2.95		

2.0 MHz

6502A	2.69
6520A	2.95
6522A	5.95
6532A	11.95
6545A	3.95
6551A	6.95

3.0 MHz

6502B	4.25

Z-80

2.5 MHz

Z80-CPU	1.25

4.0 MHz

Z80A-CPU	1.29
Z80A-CTC	1.69
Z80A-DART	5.95
Z80A-DMA	5.95
Z80A-PIO	1.89
Z80A-SIO 0	5.95
Z80A-SIO 1	5.95
Z80A-SIO 2	5.95

6.0 MHz

Z80B-CPU	2.75
Z80B-CTC	4.25
Z80B-PIO	4.25
Z80B-DART	6.95
Z80B-SIO 0	12.95
Z80B-SIO 2	12.95
Z8671 ZILOG	9.95

6800

1.0 MHz

6800	1.95
6802	2.95
6803	3.95
6809	2.95
6809E	2.95
6810	1.95
6820	2.95
6821	1.25
6840	3.95
6843	4.95
6844	6.95
6845	2.75
6847	4.75
6850	1.95
6883	22.95

2.0 MHz

68B00	2.95
68B02	3.95
68B09E	5.49
68B09	5.99
68B21	1.85
68B45	4.95
68B50	1.75
68000	9.95

CLOCK CIRCUITS

MM58167	9.95
MM58174	9.95
MSM5832	2.95

BIT RATE GENERATORS

MC14411	9.95
BR1941	4.95
4702	9.95
COM8116	8.95

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ICL7106	9.95
ICL7107	10.95
ICL7660	1.99
ICL8038	3.85
ICM7207A	5.95
ICM7208	15.95

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1771	4.95
1791	9.95
1793	9.95
1795	12.95
1797	12.95
2791	19.95
2793	19.95
2797	29.95
8272	4.39
UPD765	4.39
MB8876	12.95
MB8877	12.95
1691	6.95
2143	6.95
9216	6.29

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AY5-1013	3.95
AY3-1015	4.95
TR1602	3.95
2651	4.95
IM6402	3.95
IM6403	9.95
INS8250	6.95
NS16450	10.95

MISC.

ADC0804	2.99
ADC0809	3.85
DAC0800	3.29
DAC0808	1.95
DAC1022	5.95
MC1408L8	1.95
8T28	1.29
8T97	.59
DP8304	2.29
9334	1.75
9368	2.85
9602	.69
ULN2003	.79
MAX232	7.95
MC3470	1.95
MC3487	2.95
AY5-3600 PRD	11.95

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V20*	5 MHz	8.95
V20*	8 MHz	10.95
V20*	10 MHz	12.95
V30	8 MHz	13.95

*Replaces 8088 to speed up PC 10-40%

CRYSTALS

32.768 KHz	.95
1.0 MHz	2.95
1.8432	2.95
2.0	1.95
2.4576	1.95
3.579545	1.95
4.0	1.95
5.0	1.95
5.0688	1.95
6.0	1.95
6.144	1.95
8.0	1.95
10.0	1.95
10.738635	1.95
12.0	1.95
14.31818	1.95
16.0	1.95
18.0	1.95
18.432	1.95
20.0	1.95
22.1184	1.95
24.0	1.95
32.0	1.95

OSCILLATORS

1.0MHz	5.95
1.8432	5.95
2.0	5.95
2.4576	5.95
2.5	5.95
4.0	4.95
5.0688	4.95
6.0	4.95
6.144	4.95
8.0	4.95
10.0	4.95
12.0	4.95
16.0	4.95
18.432	4.95
20.0	4.95
24.0	4.95

PALS

16L8	$2.95
16R8	$2.95
16R6	$2.95
16R4	$2.95

74F/74S

74F00	.35
74F02	.35
74F04	.35
74F08	.35
74F10	.35
74F32	.35
74F64	.55
74F74	.39
74F86	.55
74F138	.79
74F139	.79
74F253	.89
74F157	.89
74F240	1.29
74S00	.29
74S02	.29
74S04	.29
74S08	.35
74S10	.29
74S32	.35
74S74	.49
74S86	.35
74S112	.50
74S124	2.75
74S138	.79
74S153	.79
74S157	.79
74S158	.95
74S163	1.29
74S175	.79
74S195	1.49
74S240	1.49
74S241	1.49
74S244	1.49
74S280	3.95
74S287	1.69
74S288	1.69
74S299	2.95
74S373	1.69
74S374	1.69
74S471	4.95
74S571	2.95

CMOS/HIGH SPEED CMOS

4001	.19	4066	.29	74HC154	1.09
4011	.19	4069	.19	74HC157	.55
4012	.25	4070	.29	74HC244	.85
4013	.35	4081	.22	74HC245	.85
4015	.29	4093	.49	74HC273	.69
4016	.29	14411	9.95	74HC373	.69
4017	.49	14433	14.95	74HC374	.69
4018	.69	14497	6.95	74HCT00	.25
4020	.59	4503	.49	74HCT02	.25
4021	.69	4511	.69	74HCT04	.27
4023	.25	4518	.85	74HCT08	.25
4024	.49	4528	.79	74HCT32	.27
4025	.25	4538	.95	74HCT74	.45
4027	.39	4702	9.95	74HCT138	.55
4028	.65	74HC00	.21	74HCT139	.55
4040	.69	74HC02	.21	74HCT161	.79
4042	.59	74HC04	.25	74HCT240	.89
4044	.69	74HC08	.25	74HCT244	.89
4046	.69	74HC10	.25	74HCT245	.99
4047	.69	74HC14	.35	74HCT273	.99
4049	.29	74HC32	.35	74HCT373	.99
4050	.29	74HC74	.35	74HCT374	.99
4051	.69	74HC86	.45	74HCT393	.99
4052	.69	74HC138	.45	74HCT4017	1.19
4053	.69	74HC139	.45	74HCT4040	.99
4060	.69	74HC151	.59	74HCT4060	1.49

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CIRCLE 18 ON FREE INFORMATION CARD

CAPACITORS

TANTALUM

1.0µ	15V	12	1.0µ	35V	.45
6.8	15V	42	2.2	35V	.19
10	15V	45	4.7	35V	.39
22	15V	99	10	35V	.69

DISC

10µ	50V	.05	.001µ	50V	.05
22	50V	.05	.005	50V	.05
33	50V	.05	.01	50V	.07
47	50V	.05	.05	50V	.07
100	50V	.05	1	12V	.10
220	50V	.05	1	50V	.12

MONOLITHIC

.01µ	50V	.14	1µ	50V	.18
.047µ	50V	.15	47µ	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
1µ	25V	.14	1µ	50V	.14
4.7	50V	.11	10	50V	.16
10	50V	.11	22	16V	.14
47	35V	.13	47	50V	.19
100	16V	.15	100	35V	.19
220	35V	.20	470	50V	.29
470	25V	.30	1000	16V	.29
2200	16V	.70	2200	16V	.70
4700	25V	1.45	4700	16V	1.25

VOLTAGE REGULATORS

7805T	.49	7812K	1.39
7808T	.49	7905K	1.69
7812T	.49	7912K	1.49
7815T	.49	78L05	.49
7905T	.59	78L12	.49
7908T	.59	79L05	.69
7912T	.59	79L12	1.49
7915T	.59	LM323K	4.79
7805K	1.59	LM338K	6.95

DISCRETE

1N751	.15	4N28	.69
1N4148	25/$1.00	4N33	.89
1N4004	10/$1.00	4N37	1.19
1N5402	.25	MCT-2	.59
KBP02	.55	MCT-6	1.29
2N2222	.25	TIL-111	.99
PN2222	.10	2N3906	.10
2N2907	.25	2N4401	.25
2N3055	.79	2N4402	.25
2N3904	.10	2N4403	.25
4N26	.69	2N6045	1.75
4N27	.69	TIP31	.49

SOLDER STATION

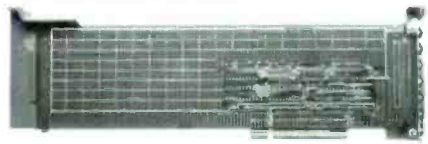
UL APPROVED

- ADJUSTABLE HEAT SETTING WITH TIP TEMPERATURE READOUT
- REPLACEMENT TIPS AVAILABLE $2.95

$49.95

WIREWRAP PROTOTYPE CARDS

FR-4 EPOXY GLASS LAMINATE WITH GOLD PLATED EDGE CARD FINGERS
SILK SCREENED LEGENDS. MOUNTING BRACKETS INCLUDED



FOR PS/2

JDR-PR32	32 BIT PROTOTYPE CARD	69.95
JDR-PR16	16 BIT CARD WITH I/O DECODING LAYOUT	49.95
JDR-PR16PK	PARTS KIT FOR JDR-PR16 ABOVE	15.95
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FOR AT

JDR-PR10	16 BIT CARD WITH I/O DECODING LAYOUT	34.95
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.01 µ CERAMIC DISC	100	$5.00
.01 µ MONOLITHIC	100	$10.00
.1 µ CERAMIC DISC	100	$6.50
.1 µ MONOLITHIC	100	$12.50

RESISTOR NETWORKS

SIP	10 PIN	9 RESISTOR	.69
SIP	8 PIN	7 RESISTOR	.59
DIP	16 PIN	8 RESISTOR	1.09
DIP	16 PIN	15 RESISTOR	1.09
DIP	14 PIN	7 RESISTOR	.99
DIP	14 PIN	13 RESISTOR	.99

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CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER. ALL WITH .1" CENTERS

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2x40	2 STRAIGHT LEADS	2.49
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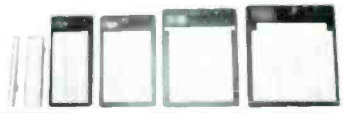

IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS					
		10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
RIBBON HEADER	IDMxx	---	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
10' GREY RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS SEE D SUBMINIATURE CONNECTORS BELOW

3 VOLT LITHIUM BATTERY

$1.95

HOLDER $1.49

SPECTRONICS CORPORATION EPROM ERASERS

Model	Timer	Chip Capacity	Intensity (uW Cm²)	Unit Cost
PE 140	NO	9	8,000	$89
PE 140T	YES	9	8,000	$139
PE 240T	YES	12	9,600	$189

D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS					
			9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.59	.69	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	---	.79	2.27	---
	FEMALE	DBxxSR	.55	.75	---	.85	2.49	---
WIREWRAP	MALE	DBxxPWW	1.69	2.56	---	3.89	5.60	---
	FEMALE	DBxxSWW	2.76	4.27	---	6.84	9.95	---
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.99	---	2.25	4.25	---
	FEMALE	IDBxxS	1.45	2.05	---	2.35	4.49	---
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	---	---
	GREY	HOODxx	.39	.39	---	.39	.69	.75

ORDERING INSTRUCTIONS
INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED xx OF THE ORDER BY PART NUMBER LISTED. EXAMPLE: A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR

MOUNTING HARDWARE 59¢

RS-232 BREAKOUT BOX

FOR TROUBLESHOOTING SERIAL COMMUNICATIONS

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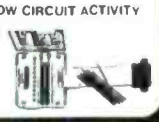
- 20 JUMPERS CROSS-CONNECT ANY TWO CIRCUITS
- 10 LEDS SHOW CIRCUIT ACTIVITY
- GENDER-BO $34.95



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- ERASES 2 EPROMS IN 10 MINUTES
- VERY COMPACT, NO DRAWER
- THIN METAL SHUTTER PREVENTS UV LIGHT FROM ESCAPING

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FOR 25 PIN D-SUBMINIATURE CONNECTORS

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GENDER-MM	MALE-MALE	7.95
GENDER-MF	MALE-FEMALE	7.95
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GENDER-JB	JUMPER BOX	8.95
GENDER-MT	MINITESTER	14.95

JOYSTICK

- SET X-Y AXIS FOR AUTO CENTER OR FREE MOVEMENT
- FIRE BUTTON FOR USE WITH GAME SOFTWARE
- ADAPTOR CABLE FOR IBM, APPLE II

$19.95

IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS								
		8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	11	11	12	15	18	15	20	22	30
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Handyman's Handbook?

I'm a new subscriber to **Hands-on Electronics**, and find it quite interesting. For several years now, I've been doing repair work for friends and relatives. When transistors came on the scene, I took some courses and learned how to service solid-state equipment also.

Now I have people asking me about repairing automobile radios and tape players with digitally synthesized PLL (all-electronic tuning). I've also had requests about cordless-phone repairs. Many repair shops tell people that the cost to repair those units is prohibitive, and advise them to buy new equipment.

It seems a shame to junk those units that look almost new. Can you recommend any books about servicing that equipment? Where can I can obtain them?
—E.W.O., Odgen, IL

Our sister magazine, **Radio-Electronics**, *ran a story on servicing cordless telephones in their May, June, and July, 1985 issues. Those magazines can also be ordered through the Reprint Bookstore.*

Starlight Serenade!

I was very happy to see my article, "Starlight Synth" in the June 1988 issue of **Hands-on Electronics**. However, the schematic you printed contained a few errors.

In Fig. 1, B1 should not go between the collector and emitter of Q15. Instead, it should go between pin 14 and pin 7 of the 556 timing chip. Also in Fig. 1, S1 should be between the positive lead from B1 and pin 14 of that integrated circuit.

I hope that straightens out any problems your readers might encounter.
—Timothy A. Riggs

Making (Air) Waves

I like your magazine, and I hope you keep up the entry-level electronics articles.

I have a question regarding the "Sonic Jacket" featured in the "Gizmo/Bytes" section in the July 1988 issue. It contains speakers, an amplifier, and a battery pack built into the jacket itself.

Can you picture a person trying to explain *that* to Airport Security?
—W.M.S., Marina, CA

It might be fun to watch! But as you may know, the use of any electronic device on planes is restricted, especially receivers. That makes using the jacket on the plane a no-no in the first place. So, if you've got one, pack it or leave it at home.

Haves and Needs

I would like to know how to build a voice-activated/recognition device. If anyone can help, please write to me.

Timothy Green
2034 Ocee Drive
Riverdale, GA 30296

I am looking for information on my audio amplifier, made by the "Great American Sound Co., Inc." of Chatsworth, CA. There is no apparent model number on the unit—it might simply be called "Son of Ampzilla."

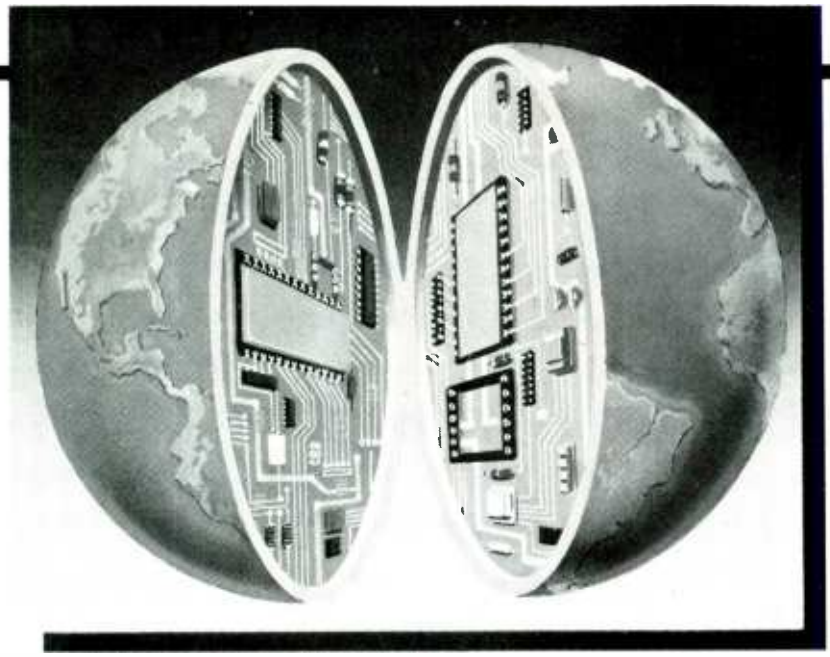
I have attempted to contact the company, with no success. I need a parts list and schematics for that unit, or a current address of the manufacturer. Thank you.

Randy E. Meyer
715 Park Avenue
So. Milwaukee, WI 53172

I am desperately in need of a schematic for a Teledyne 4-Channel Quadrasonic Radio Receiver, Model No. RA-632.

I've tried Olson Electronics, who suggested I write to Teledyne Corp., who told me to try Cube Master—who seems to have disappeared!

Robert K. Browne
9818 McKnight, NE
Albuquerque, NM 98112 ■



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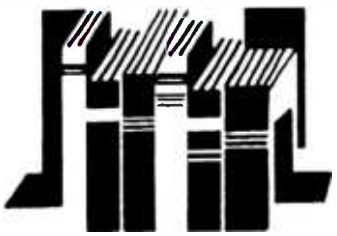

Electronics Library

20 INNOVATIVE ELECTRONICS PROJECTS FOR YOUR HOME

by Joseph O'Connell

Hobbyists might decide to build a project because they can't buy it anywhere, because it's cheaper to make it themselves, or just for the fun of it. This 264-page book has projects in each of those categories—and some that overlap. The emphasis is on unique, yet practical devices that are time-saving and cost-efficient.

Readers learn how to make a portable mini-refrigerator from a cooler, a solid-state blanket controller, active mini-speakers with built-in amplifiers, a fluorescent bike light, a ringing-telephone alerter, and more. Each chapter contains a description of the circuit, construction details, photographs and diagrams, and a discussion on how to use the circuit.

Complete parts lists accompany each project, and a separate chapter lists sources for new and surplus parts and explains when it is better to buy used parts. A chapter on construction contains advice on tools and materials, soldering irons, test equipment, and various construction methods. In addition to the 20 main projects, a chapter on electronics contains some simple circuits and helpful hints on circuit design and modification.

20 Innovative Electronics Projects For Your Home is available for $13.95 from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

PRINTER TROUBLESHOOTING & REPAIR

by John Heilborn

Syndicated computer columnist John Heilborn has written this book for intermediate to advanced computer users with a basic understanding of electronics. It provides answers to the most common printer-repair problems, and covers dot-matrix, ink-jet, and laser printers.

Printer Troubleshooting & Repair begins with a description of each type of printer and how they work. Theory of operation, design concepts, and component identification are discussed, followed by basic troubleshooting techniques. By understanding how printers should work, the reader will be better able to localize the trouble when they don't work.

Subsequent chapters contain detailed troubleshooting and repair information for each type of printer. Charts, schematics, and component lists are included. The author discusses tools and test equipment, soldering techniques, and guidelines and cautions for making repairs. Each part of the printer—print heads, transport mechanisms, power systems, logic and control systems—is discussed separately and in relation to other parts.

This 194-page book also includes a section on preventive maintenance, to help readers prolong the lives of their printers. Two useful appendices provide IC-pinout diagrams to facilitate the identification of the input, output, power, and ground connections for logic-IC devices; and a listing of printer manufacturers and suppliers.

Printer Troubleshooting & Repair (No. 22543) costs $19.95. It is available from bookstores, computer stores, and electronics distributors, or from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

QUATTRO: THE PROFESSIONAL SPREADSHEET MADE EASY

by Lisa Biow

Quattro software offers a combination of spreadsheet, database, and graphics that is easy to use and is very powerful. This 600-page book provides a thorough background in the basics of spreadsheet organization and design for readers who are new to Quattro, or to spreadsheet software in general.

Quattro: The Professional Spreadsheet Made Easy begins with the fundamentals of creating and using Quattro worksheets—entering and editing data, saving and retrieving worksheets, manipulating blocks of data, rearranging and formatting worksheets, and printing reports. With clear instructions and hands-on exercises, readers quickly learn to design a spreadsheet, modify data, and use formulas.

More-advanced concepts and techniques are also presented, including graphing, database design, macros, the use of functions, and methods of customizing Quattro. There is a complete chapter on the principles and strategy of spreadsheet design. When those concepts are applied to the specific commands and techniques presented in preceding chapters, the result is a sophisticated, well-designed spreadsheet.

Four appendices contain an installation guide, a summary of Quattro's 100 functions, helpful hints for Lotus 1-2-3 users who are switching to Quattro, and a list of commands.

Quattro: The Professional Spreadsheet Made Easy is available for $19.95 from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

CIRCLE 84 ON FREE INFORMATION CARD

ELECTRONIC HOBBYISTS HANDBOOK

by R.A. Penfold

As electronics becomes increasingly complex, the hobbyist is confronted with a tremendous amount of data. The *Electronics Hobbyists Handbook* provides a useful collection of data for the amateur electronics enthusiast, so that much of the data he needs is available in a single source.

The book covers common component-color codes, and details the characteristics and pinouts of many popular semiconductor devices—including logic ICs, op-amps, transistors, FETs, SCRs, triacs, diodes, rectifiers, and regulators. Several types of circuits are illustrated, including timers, oscillators, audio amplifiers, and filters. There is a separate section on power supplies. Circuit symbols, interface details, amateur- and CB-frequency allocations are also presented in this 88-page book.

Some knowledge of electronics is needed to make use of the data, which is intended for students, designers, and technicians, as well as hobbyists.

The Electronic Hobbyists Handbook (order No. BP233) is available for $11.95 from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

CIRCLE 97 ON FREE INFORMATION CARD

UNDERSTANDING DATA COMMUNICATIONS, SECOND EDITION

Edited by Gilbert Held

Data communications—the process of communicating information using binary signals—has become vital to the American economy, and is rapidly gaining importance in homes as well. This 291-page book explains how data-communications systems, and their various hardware and software components, work.

Understanding Data Communications, Second Edition covers the basic concepts and principles of data-communications systems in general. Opening with a history and overview, the book discusses data terminals, messages and transmission channels, asynchronous and synchronous modems, interfaces, digital transmissions, fiber-optic and satellite communications, protocols, and error control.

Tips are given for setting up a system to communicate between a personal or professional computer and either another personal computer, a data-base service, or an electronic-bulletin board. Information is included on architectures and packet networks, network design and management, Integrated Services Digital Network (ISDN), and the Hayes modem-command set.

Using a text-book format, each chapter begins with an introduction and concludes with a summary of the material presented and a self-quiz.

Understanding Data Communications, Second Edition is available for $17.95 from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

1988 SHORT FORM CATALOG

LEADER INSTRUMENTS CORPORATION

This 4-page brochure presents a cross-section of Leader's line of more than 100 test and measurement instruments. It features oscilloscopes, professional video-test equipment, signal generators, audio- and video-service instruments, frequency counters, and power supplies.

Each item is illustrated with a photograph. Specifications are provided, as well as a description of each unit.

Several new items are featured in this catalog. Those include a combination digital multimeter/digital-storage scope with companion printer, a synthesized NTSC-test/sync-signal generator, a combination waveform monitor/vectorscope, an AM/FM-stereo signal generator, and two battery-powered NTSC-pattern generators.

The 1988 Short Form Catalog is free upon request from Leader Instruments Corporation, 380 Oser Avenue, Hauppauge, NY 11788; Tel. 1-800-645-5104.

CIRCLE 56 ON FREE INFORMATION CARD

MICROSOFT WORD MADE EASY, THIRD EDITION

by Paul Hoffman

This book, which shows new Word users how to handle that powerful word-processing program with skill and confidence, has been revised to include all the features of Word version 4. Versions 1 through 3 are also covered.

Microsoft Word Made Easy explains the concepts behind Word's features, and reinforces the concepts with do-it-yourself examples. Each chapter is divided into lessons that are illustrated with screen photos, and ends with review exercises.

The 405-page book gives a complete overview of Word's editing features and formatting commands; discusses general topTics such as printing, merging, and various options; and shows how to use advanced features—outlines, tables of contents, spelling correction, indexes, and sorting—to prepare business documents. The new features in version 4, such as macros and advanced document retrieval, are covered. Also included are special features for legal documents, desktop-publishing projects, text outlining, and windows.

For beginners, the book teaches basic word-processing terms and describes in detail how to get started. The lessons build on material presented earlier in the text, making it easy to advance. Readers with some Word experience will find topics mentioned briefly in the Microsoft Word manual elaborated upon in this book. Advanced users will appreciate reference material throughout the book, particularly in the appendices.

Those appendices summarize editing and formatting commands, mouse keyclicks, and the Word Command Tree; and describe

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◀ ☐ **BP59—2ND BOOK OF CMOS IC PROJECTS** . . . . $5.50. Still more ways to use these versatile devices. None of these projects overlap those in book #224. The pair make a wonderful circuit reference set.

☐ **BP84—DIGITAL IC PROJECTS** . . . . $5.50. Both simple and more advanced projects to help the reader develop a knowledge of the workings of digital circuits. A number of board layouts are included. ▶

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Electronics Library

how to prepare the Word program, use other programs with Word, and alter printer drivers; and present the answers to the review exercises.

Microsoft Word Made Easy, Third Edition costs $18.95, and is available from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

CIRCLE 96 ON FREE INFORMATION CARD

EXPERT SYSTEMS AND ARTIFICIAL INTELLIGENCE: APPLICATIONS AND MANAGEMENT

Edited by Thomas C. Bartee

This 304-page book is a collection of essays written by leading authorities in Artificial Intelligence (AI). It highlights the applications of AI in finance, communications, space, and military systems. Aimed at the professional-level business person, analyst, or computer scientist working with expert systems or other AI disciplines, the book thoroughly explains problem solving, knowledge representation, and natural-language processing.

Expert Systems and Artificial Intelligence: Applications and Management presents an overview of the basic principles of AI, examines current applications in several fields, and discusses ongoing research and future applications. The book also presents valuable insights into the history and development of artificial intelligence.

Priced at $39.95, in hardcover only, Expert Systems and Artificial Intelligence: Applications and Management is available at computer stores, bookstores, electronics distributors, or directly from the publisher, Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

IBM PS/2 HANDBOOK

by Richard Dalton with Scott Mueller

IBM's Personal System/2 (PS/2) computers are redefining the personal computer market. Not simply another new computer, PS/2 is a family of new machines, monitors, printers, and a desktop-publishing package. The *IBM PS/2 Handbook* is a comprehensive guide to each of the new machines and components. It details how the new systems perform better than previous IBM computers, and explains the various audiences for the different models.

The book explains how the reader can benefit from the PS/2. It describes the technological breakthroughs behind the system, including the new system-board design, MCGA and VGA graphics, and Micro Channel Architecture, and how they work to bring the user unprecedented power.

For people considering the purchase of a PS/2, *IBM PS/2 Handbook* describes the innovative features that distinguish each particular machine, from the low-end Model 25 to the high-powered Model 80. The book's checklists also help readers determine which machine best suits their needs.

Readers who already own a PS/2 can learn how to realize their system's maximum potential. The differences and similarities of the new OS/2 and PC DOS 3.3 operating systems are explored, to aid readers in the selection of software and hardware products that will best meet their PS/2 needs. The book also describes how to communicate and exchange data between a new PS/2 and an existing PC, with a minimum of difficulty.

IBM PS/2 Handbook contains 358 pages, and costs 19.95. It is available from Que Corporation, P.O. Box 90, Carmel, IN 46032; Tel. 1-800-428-5331.

CIRCLE 94 ON FREE INFORMATION CARD

EXPERIMENTS WITH EPROMS

by Dave Prochnow

Erasable Programmable Read-Only Memory devices (EPROMs) are dual in-line packages capable of holding any user-supplied programming in a nonvolatile fashion—yet they can be quickly erased at the user's discretion, and reprogrammed to perform a different function. Virtually any design that uses microprocessor control or requires external data for its operation can be easily modified to accept EPROM programming.

Incorporating EPROMs into digital circuits isn't difficult—if you have an EPROM programmer, an EPROM eraser, and practical instructions. *Experiments with EPROMS* provides all three. The book begins with a detailed explanation of underlying theory, including discussions of digital memory, binary codes, mathematics, and logic, then goes on to desscribe fifteen EPROM projects, including plans for several programmers and erasers.

Other projects featured in this 230-page book are a Boole's Box, a keyboard encoder, a ROM drive, speech and music synthesizers, and an EPROM-program tester. The step-by-step plans give home-electronics, robotics, and computer experimenters hands-on understanding of how EPROMs work.

Complete specifications and pin-outs for 19 popular PROMs, EEPROMs, and EPROMs in current use are included in *Experiments with EPROMS*. The book also explores commercially-available programmers and erasers, and provides an over-

view of alternate memory technologies. Although the book is aimed at intermediate to experienced hobbyists, three appendices—building an EPROM project, IC data sheets, and a list of suppliers—provide guidance for beginners, and helpful tips for all readers.

Experiments with EPROMS costs $16.60 in paperback or $24.95 in hardcover, from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

AN INTRODUCTION TO ANTENNA THEORY

by H. C. Wright

When any conducting body is exposed to a radio wave, it will have electrical currents induced into it. Conversely, any conductor carrying currents will radiate. Thus, many common objects can be used as antennas. The experimenter can test his ideas and innovations, particularly with TV and CB wavelengths, with little more than bent copper wire.

An Introduction to Antenna Theory covers the basic concepts relevant to receiving and transmitting antennas. This heavily illustrated book emphasizes the mechanisms involved, and minimizes the mathematics used.

The 86-page book begins with a definition of the antenna and general wave-motion. It discusses electromagnetic waves, antenna efficiency, resistance to radiation, complex impedance, reciprocity, directionality, and parasitic elements. It describes several types of antennas—including simple transmitting, frame, helical, slot, dielectric-clad, microwave, long-wire, travelling-wave, superconducting, and active antennas.

An Introduction to Antenna Theory (order No. BP198) is available for $8.95 from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

CIRCLE 97 ON FREE INFORMATION CARD

MICROSOFT WORD: THE COMPLETE REFERENCE

By Eric Alderman

Written for all *Microsoft Word* users, this comprehensive guide contains detailed listings of all functions and commands. The new features of *Version 4.*—revision marks, document retrieval, line and box drawing, paragraph borders, remappable function keys, and its powerful macro language—are included.

Microsoft Word: The Complete Reference is divided into three sections for easy access to information. It begins with an introduction to the *Word*'s basic features, including its displays and menus, editing, and fin

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Please have the make and model # of the equipment used in your area. *Thank You*

Electronics Library

ishing documents. Novices as well as experienced *Word* users will find the alphabetical reference section to be a quick, convenient way to locate commands and features. Each entry begins with a description, and then explains the steps followed to use the command or features. Part 3 is a guide to advanced features, such as style sheets, glossaries, macros, tables and indexing, outlining, and columns. There are also appendices covering installation, keyboard and mouse references, windows and pageview features, and the differences between *Version 3* and *Version 4*.

Microsoft Word: The Complete Reference contains 554 pages, and is available for $24.95 from Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710.

CIRCLE 96 ON FREE INFORMATION CARD

PRACTICAL MIDI HANDBOOK

By R.A. Penfold

The Musical Instrument Digital Interface (MIDI) is a means of swapping information between suitably-equipped, electronic musical instruments, and is often used for computer control of instruments. Its main advantage is that it is a true standard, adopted by many manufacturers—so that any instrument equipped with MIDI sockets will work with any other piece of MIDI equipment, from any manufacturer.

MIDI has been surrounded by misunderstanding, however, and the highly-technical user manuals accompanying the equipment often add to the confusion. The *Practical MIDI Handbook* is intended to clarify things for the reader. It is aimed at musicians, technicians, and enthusiasts who want to explore the capabilities of MIDI, but are prevented from doing so because they have little prior knowledge of electronics or computers.

The basics of MIDI are explained, including such things as interconnecting a system, and why MIDI is needed at all. Most of the book is devoted to an explanation of what MIDI can do—and how to get the most from it. The *Practical MIDI Handbook* covers the fundamentals of control codes, describes the types of equipment and software currently available, and explains how systems can be tailored to meet individual requirements.

While the main emphasis is on actually using MIDI systems, theory and technical details are included as well. Full details of the MIDI-code numbers are provided for those who wish to do their own MIDI programming. Also included is advice on deciphering the technical material in the owner's manuals.

The Practical MIDI Handbook (order No. PCP103) contains 150 pages, including a glossary of terms. It is available for $11.95, including shipping, from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762.

CIRCLE 97 ON FREE INFORMATION CARD

LEARNING ELECTRONICS: THEORY AND EXPERIMENTS

by R. Jesse Phagan and William Spaulding

This comprehensive guide combines electronics theory, math, and hands-on experience with computer-aided instruction using the Commodore 64/128. No previous electronics or computer experience is required for understanding the material presented in this book.

The book's main emphasis is on student-managed learning; its key is the involvement of the student in the learning process. Each chapter—after the first two introductory chapters—has a computer program to quiz the student on the information presented. Other programs provide practice and experience with ohmmeters, voltmeters, ammeters, and oscilloscopes.

Learning Electronics: Theory and Experiments explains the fundamentals of electronics, including the math necessary to support each concept. Some of the topics covered are meters, DC and AC circuits, soldering techniques, basic hand tools, and engineering notation.

Projects and experiments illustrate the principles that are presented throughout the text, and practice exercises in mathematics are included. Sample exams and answers are also provided. Computer programs, which graphically illustrate the electronic concepts and mathematical relationships, are supplied.

Learning Electronics: Theory and Experiments costs $16.95 and is available from Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-233-1128.

CIRCLE 98 ON FREE INFORMATION CARD

CRASH COURSE IN ELECTRONICS TECHNOLOGY

By Louis E. Frenzel, Jr.

If this book seems familiar at first glance, that's because its author, Louis E. Frenzel, Jr., has been writing learning courses for **Hands-on Electronics** for years. Like his articles, *Crash Course in Electronics Technology* is a tutorial with a step-by-step format. It will help hobbyists, students, and laypersons learn the basics of electricity and electronics.

Crash Course in Electronics Technology is a complete self-study course in the fundamentals of electronics. Written at the technician level, it can be used alone, as a supplement to a regular classroom course, or as a refresher course on a particular subject.

A brief introduction to electricity is followed by a discussion of circuit basics and electronic devices. The book continues with a presentation of electronic communication, controls, test equipment, and troubleshooting techniques. Some of the other topics that are covered in the text are magnetism, resistors, inductance and transformers, capacitors, diodes, transistors, amplifiers and op-amps, amplitude and frequency, and pulse techniques.

Everything is presented in a self-paced, instructional format. There are many clear and informative illustrations, numerous examples that help enhance understanding, and each chapter concludes with a self-test review of the material.

Crash Course in Electronics Technology (order No. 22494) costs $21.95, from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 462ts $21.95, from Howard W. Sams & Company, 4300 West 62nd St., Indianapolis, IN 46268; Tel. 800-428-SAMS.

CIRCLE 95 ON FREE INFORMATION CARD

RADIO'S FIRST TWO DECADES

Consisting of selections from *Radio Start to Finish*—originally published *By Thomas Y. Crowell Co.in 1942—Radio's First Two Decades* is an informative journey back in time. Whether you can remember the early days, or are a member of the newer generation of radio enthusiasts, this book tells an exciting story of the pioneers in the development of radio.

Beginning with Marconi's wireless experiments in 1895, *Radio's First Two Decades* describes the earlier discoveries of Maxwell and Hertz, upon which Marconi based his experiments. The story of how Marconi spanned the ocean is told, illustrated with photographs of some of the actual equipment used. The book tells of Fessenden, the first man to transmit the human voice By wireless; DeForest, the developer of the audion, or vacuum tube; and those men whose visions led to the beginning of broadcasting. It ends with the start of radio as we know it—the establishment of station KDKA, and the first public broadcasts of sports, music, and political events to an eager public.

Radio's First Two Decades (order No. RFTD) costs $4.75, including shipping. It is by mail order available from Electronics Technology Today, P.O. Box 240, Massapequa, NY 11762 ■

CIRCLE 95 ON FREE INFORMATION CARD

A Science Brief:

THE GRAVITY OF THINGS

A team of scientists will travel to Greenland in July to make some of the most sensitive geophysical measurements ever made of the Newtonian gravitational constant, and to test a new theory that a fifth, yet undiscovered, force may exist in the universe.

The experiment is designed to detect and measure possible variations in the gravity constant over distances in excess of 300 feet, far beyond the laboratory measurements of gravity that are generally limited to lengths of a few inches. The discovery of gravitational variations would have a significant impact on several branches of modern physics, and would require the recalculation of the masses of planets and stars.

Geophysicists Mark A. Zumberge, from the University of California, San Diego, Institute of Geophysics and Planetary Physics at the Scripps Institution of Oceanography, and Mark E. Ander, from the University of California, Los Alamos National Laboratory, will lower a gravity meter down a hole bored into the Greenland ice cap to accurately measure the gravitational constant first determined by Sir Issac Newton more than 300 years ago. The universal constant is commonly called "big G" by physicists to distinguish it from local gravity, "little g", which varies continually with relation to the surrounding mass.

The Newtonian gravitational constant, G, is one of the most important and least well determined of fundamental physical constants. "If the effective gravitational constant can be proved to be dependent upon distance, it will mean that a fifth force exists in nature," commented Ander. Such a finding could assist physicists in the pursuit of a unified field theory that could tie together the known forces of gravity and electromagnetism and the concepts of strong and weak forces—two factors of nuclear particle physics. It will also profoundly effect other branches of physics such as general relativity, astrophysics, and cosmology.

During the experiment, the research team will measure the changes in the force of gravity at different depths within the remote location known as DYE 3, where the United States, in cooperation with the Danish government, operates an Air-Force radar station. The gravity meter will be lowered down the borehole to a depth of about 5,000 feet and then raised in 300-foot intervals where measurements will be taken. About a dozen readings will be taken as the instrument moves up the hole. Calculations from these measurements will determine the value of the force of gravity inside the hole as a function of the position of the instrument in the huge ice sheet. The gravitational effects of the earth beneath the ice will be factored out of the final calculations.

The investigation is supported by the NSF Divisions of the Polar Programs and Physics, Los Alamos National Laboratory, and additional funding from Amaco Production Company, Mobil Research and Development company, and the Air Force Geophysics Laboratory in Bedford, Massachusetts.

(Continued on page 106)

2141

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NEW PRODUCTS

True RMS Multimeter

The *Fluke 87* handheld digital multimeter offers a powerful combination of measurement functions, including frequency, duty cycle, capacitance, minimum/maximum/average recording, MIN MAX Alert, and Input Alert.

The Input Alert safety feature warns the user when the leads are connected to the current jack while the meter is selected for voltage or resistance. The MIN MAX Alert pinpoints intermittent failures by signaling the user with a short beep when a new minimum or maximum value has been recorded.

The Fluke 87's analog display, which is updated 40 times per second, is a high-resolution pointer. The display can be back lit, and has a user-selectable 4½-digit (20,000 count) mode, in addition to its standard 3¾ (4000 count) digital display. A true RMS multimeter, the Fluke 87 also features a peak MIN MAX recording mode, with 1-ms response, that is ideal for capturing transient events.

CIRCLE 40 ON FREE INFORMATION CARD

The digital multimeter features a relative (zero) mode, has Touch Hold capability, which senses a stable reading and locks it on the display, for convenient viewing after the test leads have been removed. It has a 20-kHz AC-voltage response, and DC accuracy to within 0.1%.

The Fluke 87 is overload-protected to 1000 volts in ohms and diode test. It is EMI-shielded, and is packaged in a splash- and dust-proof case, with a protective holster. The case's unique flexible-rubber stand allows the meter to be hung from doors or pipes, as well as being used as a normal tilt-leg.

The Fluke 87, which carries a three-year warranty, will be available November 1st, for a suggested retail price of $259.00. For further information, contact *John Fluke Mfg. Co., Inc.*, P.O. Box C9090, Everett, WA 98206; Tel. 800-443-5853.

26-Inch Monitor/Receiver

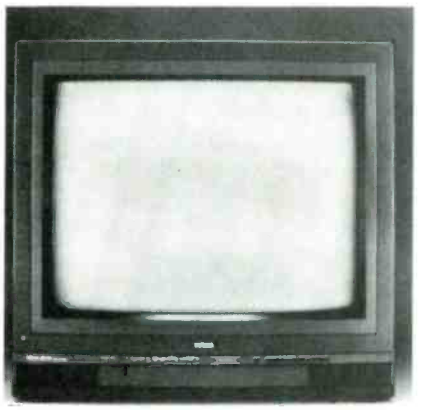
Yamaha Electronics Corporation's Model YM-265S video monitor/receiver has a high-resolution 26-inch screen, infrared-remote control, Separate Audio Program (SAP), Multichannel Television Sound (MTS) stereo, and Super-VHS compatibility.

The YM-265S has a high-contrast tinted CRT, comb-filter circuitry, a black-matrix screen, and 560 lines of horizontal resolution—resulting in a sharp image. S-VHS compatibility is achieved through a new S-connector.

The unit has antenna inputs for reception of all VHF, UHF, and major cable channels—142 channels in all—and accurate reception is assured by the frequency-synthesized tuner. The numeric keys on the remote control provide direct access to any channel, or the up/down tuning controls can be programmed to scan, skipping over unused channels.

The YM-965S's infrared-remote control also operates power, volume, and muting. The unit's input-source switching, and digital-clock and timer display, can also be controlled remotely. An on-screen channel and time display can be switched on using the remote or from the front panel.

It can receive standard broadcast-TV sound, MTS stereo, and SAP. LED indicators make sound-source selection easy. An audio-enhancer circuit makes even a mono signal sound impressive. Slim speakers, built in to the bottom of the unit's front panel and driven by a 2.5-watt amplifier, further enhance its sound.



CIRCLE 41 ON FREE INFORMATION CARD

The YM-965S also has external optional-speaker outputs powered by a 5-watt amplifier, and rear-panel audio outputs for connection to a stereo system. Two sets of audio and video terminals, a monitor terminal, and an RF connector provide easy connection to other components in an audio/video system.

The suggested retail price for the YM-965S is $899.00. For more information, contact Yamaha Electronics Corporation USA, 6660 Orangethorpe Avenue, Buena Park, CA 90620.

Cordless Phone

The *Excursion 500* is an inexpensive, full-featured portable-cordless phone. It has a battery-low indicator; LEDs for power, in-use, and charge; a flash button; a 750-foot operating range; tone/pulse-switchable dialing; and is hearing-aid compatible.

The telephone's call bar acts as a one-way pager. When the call bar on the base is pressed, the handset buzzes, alerting the person with the handset.

Now from NRI comes the first course of its kind . . . anywhere!

Learn to use, program, and service today's digital electronic music equipment as you build your own computer-controlled music center

Now NRI puts you at the heart of the most exciting application of digital technology to date! With NRI's new at-home training in Electronic Music Technology, you get hands-on experience with the equipment that's revolutionizing the music industry—Atari ST Series computer with built-in MIDI ports, Casio CZ101 digital synthesizer with advanced MIDI capabilities, and ingenious MIDI software that links computer keyboard to synthesizer keyboard—all yours to train with and keep.

This year, over $1.5 *billion* worth of digital electronic music instruments—keyboards, guitars, drum machines, and related equipment—will be sold in the U.S. alone. Who's buying this new-tech equipment? Not just progressive musicians and professional recording technicians, but also thousands of people who have never touched a musical instrument before. And there's good reason why.

Something called MIDI (Musical Instrument Digital Interface) has suddenly transformed musical instruments into the ultimate computer peripherals . . . and opened up a whole new world of opportunity for the person who knows how to use, program, and service this extraordinary new digital equipment.

Now NRI's breakthrough Electronic Music Technology course puts you at the forefront of this booming new technology with exclusive hands-on training built around a MIDI-equipped computer, MIDI synthesizer, and MIDI software you keep.

Dynamic New Technology Opens Up New Career Opportunities for You

The opportunities are unlimited for the person who's trained to take advantage of today's electronic music phenomenon. Now you can prepare for a high-paying career as a studio technician, sound engineer, recording engineer, or road technician . . . even start your own new-age business providing one-stop sales and service for musicians, technicians, and general consumers alike. Or simply unleash your own musical creativity with the breakthrough training and equipment only NRI gives you.

Only NRI Gives You an Atari ST Computer, Casio Synthesizer, and Innovative MIDI Software You Train With and Keep

The Atari ST Series computer included in your course becomes the heart of your own computer-controlled music center. With its tremendous power, superior graphics capabilities, and built-in MIDI interface, the 16/32-bit Atari ST has almost overnight become the computer of choice for today's most knowledgeable electronic musicians.

The Casio CZ101 digital synthesizer, also included in your training, is the perfect complement to your Atari ST. The polyphonic, multitimbral CZ101—which stores up to 32 voices internally—"communicates" with your ST computer through MIDI, bringing life to virtually any sound you can imagine.

Plus, you get ingeniously designed MIDI software that opens up amazing new creative and technical possibilities . . . you actually build your own 4-input audio mixer/amplifier . . . and you test the electronic circuits at the core of today's new-tech equipment with the hand-held digital multimeter included in your course.

No previous experience necessary—in electronics or music!

No matter what your background, NRI gives you the skills you need to take advantage of today's opportunities in electronic music technology.

With your experienced NRI instructor always available to help, you master the basics of electronic theory step by step, gaining the full understanding of electronics that's now so essential for technicians and musicians alike. You move on to analyze sound generation techniques, digital logic, microprocessor fundamentals, and sampling and recording techniques . . . ultimately getting first-hand experience with today's explosive new technology as you explore MIDI, waveshaping, patching, sequencing, mixing, special effects, and much more.

Plus, even if you've never been involved with music before, NRI gives you enough basic training in music theory and musical notation to appreciate the creative potential and far-reaching applications of today's electronic music equipment.

Send Today for Your FREE Catalog

For all the details about NRI's innovative new training, send the coupon today. You'll receive a complete catalog describing NRI's Electronic Music Technology course plus NRI courses in other high-tech, in-demand electronics fields.

If the coupon is missing, write to NRI School of Electronics, McGraw-Hill Continuing Education Center, 3939 Wisconsin Avenue, Washington, DC 20016.

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NEW PRODUCTS

The Excursion 500's battery pack is consumer replaceable. It also has a replaceable antenna, further reducing the need for manufacturer service or repairs. The new antenna screws on for simple installation.

CIRCLE 42 ON FREE INFORMATION CARD

The ash-tone cordless phone is desk- or wall-mountable. It is compact—9 × 5 inches—and the handset weighs only 6½ ounces.

The Excursion 500, complete with line cord and instruction book, has a suggested list price of $79.00. For further information, contact *Northwestern Bell Phones*, 9394 West Dodge Road, Suite 100, Omaha, NE 68114.

Solderless Breadboarding Labs

3M Electronic Products Division's self-contained, solderless breadboarding labs are now available with removable circuit-board assemblies. That design allows engineers and technicians to perform multiple circuit projects—one per board—using a single *Powerace Plus-Board*. In classroom use, the removable circuit-board feature permits students to keep their individual projects on their own boards.

The Powerace *Models 202 and 203* each come with one removable circuit board. Additional boards can be purchased separately. Those models, as well as the entire Powerace line of breadboarding labs, feature internal power supplies, logic monitors, a clock generator, data-pulse sources, logic-level switches, pulse generator, and pulse detection with memory.

The Plus-Board units have two solderless breadboards with tie points laid out on a 0.1-inch × 0.1-inch matrix. Those breadboards accept all DIP sizes and a wide variety of discrete components with lead diameters of up to .032-inch. There are 1,680 plug-in tie points on each board, accommodating up to eighteen 14-pin DIPs. Mounted to an aluminum-ground plane, the boards are ideal for high-frequency and high-speed/low-noise circuits. Circuits are protected by a short-proof power supply and fused-transformer primaries.

CIRCLE 43 ON FREE INFORMATION CARD

The Models 202 and 203 (part No. 923202 and 923203) have a suggested retail price of $175.05 each. Further information is available from local 3M Electronic Specialty Products distributors, or contact: Electronic Specialty Products, 3M Electronic Products Division, 9325 Progress Parkway, P.O. Box 540, Mentor, OH 44060; Tel. 800-321-9668 (216-354-2101 in Ohio).

Tool Kit

Jensen has improved their popular *JTK-79* Electro-Mechanical Tool Kit, designed for the performance of a wide variety of electronic- and mechanical-repair tasks.

The kit contains a 14-piece socket set, a 7-piece jewelers-screwdriver set, a 10-piece hex-key set, 4 screwdriver blades, a full-size handle, a wire-stripper/cutter, assorted pliers, and more. Tools are held in a compact, 7- × 9- × 2-inch padded, zippered case. A Velcro snap closure can hold an optional Beckman DM73 Meter.

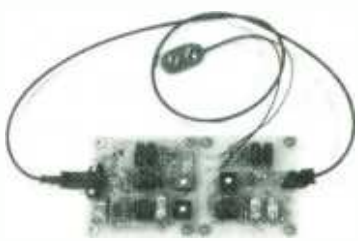
CIRCLE 44 ON FREE INFORMATION CARD

The JTK-97 costs $79.99. For more information and a free catalog, contact Jensen Tools Inc., 7815 South 46th Street, Phoenix, AZ 85044; Tel. 602-968-6231.

Fiber-Optics Experimenter Kit

Jameco's JE315 Advanced Fiber Optic Kit is designed as an educational device. It gives students, hobbyists, and engineers both a hands-on experience with fiber optics, and a better understanding of how fiber-optics technology really works.

The JE315 includes separate transmitter- and receiver-circuit boards, and an on-board oscillator for easy circuit testing. It accepts analog- or TTL-input signals, and can process multiple analog and digital signals that have been combined together previously. Its frequency range is 40 Hz to 6.5 kHz, and its circuitry includes a 555 timer chip, LM1458N op-amp ICs, and an MFOD73 photo transistor.



CIRCLE 44 ON FREE INFORMATION CARD

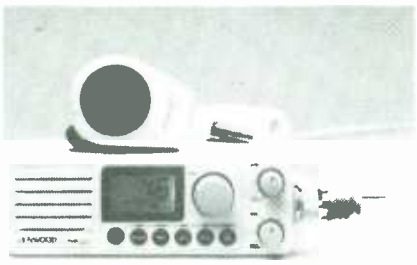
The advanced fiber-optics experimenter kit, complete with step-by-step instructions, theory of operation, and tutorial information, clearly demonstrates the principles of fiber-optic design. Model JE315 includes fiber-optic cables and connectors, and costs $29.95. For more information, contact Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002; Tel. 415-592-8097 for orders only, 415-592-8121 for all other inquiries.

VHF Marine Radio

Kenwood's TKM-407 VHF marine radio is designed for durability and reliable performance in the marine environment. Its high-impact, corrosion-

resistant plastic case covers a die-cast metal chassis. A large heat sink protects the components from vibration and damage.

The compact TKM-407 provides 25 watts of power output. For use on FCC-restricted channels, the 1-watt low-power position can be used. It has a large LCD for optimum readability in sunlight, and is illuminated for night viewing. The display can be adjusted with a dimmer switch. The front-mounted speaker is water resistant.



CIRCLE 45 ON FREE INFORMATION CARD

All U.S., Canada, and International Marine channels are factory-programmed. The TKM-4077 also receives up to ten weather channels, and can store as many as 30 other channels. The radio has a dual-watch feature that monitors Channel 16 for approximately a half second every 2 seconds, allowing the user to remain constantly in touch with Channel 16 regardless of the channel being used.

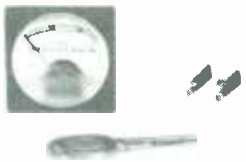
The TKM-407 has three scanning modes: Dial scan for all channels, memory scan for the 30 memory channels, and an all weather-channel scan.

With mounting bracket and water-resistant microphone, the TKM-407 has a suggested retail price of $599.99. An optional flush-mount kit is also available. Further information can be obtained from Kenwood U.S.A. Corporation, Communications & Test Equipment Group, 2201 E. Dominguez St., Long Beach, CA 90810; Tel. 213-639-4200.

Compact AC Line-Voltage Monitor

D1 Products' AC line-voltage monitor, *Model APM43*, is used to determine the status of 110-VAC and 220-VAC line voltages. A single calibrated-dial face uses colored bands to highlight the 100–120-VAC and 210–230-VAC ranges. Its full-scale voltage reading is 300 VAC.

The APM43 has a standard two-



CIRCLE 46 ON FREE INFORMATION CARD

prong plug molded into its case, allowing it to be inserted directly into an outlet. The monitor can be used as a portable hand-held meter for rapid testing of outlet voltages, or for long-term line-voltage observations.

Due to its unique case design, the APM43 AC line-voltage monitor can also be panel mounted. Serrations molded on two sides allow quick mounting by pushing it into a panel cutout for a press fit. The compact meter measures only 1.69 × 1.69 × 2.28 inches.

The APM43 is available in quantities of 100 pieces for $14.40 apiece, from D1 Products, Inc., 95 East Main St., Huntington, NY 11743.

Dubbing Cassette Decks

Onkyo has added two high-performance models to their dubbing cassette-deck line. *Models TA-RW470* and *TA-RW490* have *Dolby B* and *C* noise-reduction systems, assuring compatibility with other decks and pre-recorded tapes. The TA-RW490 also features *Dolby HX Pro* for increased high-frequency capability and reduced distortion.

Both models use dual-motor, logic-controlled transports and provide quick auto-reverse for recording or playback. A more-sensitive infrared sensor—instead of a mechanical sensor—is used to trigger direction change at the beginning of the leader tape, resulting in very short gaps between sides. The decks are compatible with Onkyo's *Remote Interactive* remote-control format, which uses bi-directional digital-data transmission to allow interaction between many components.

CIRCLE 47 ON FREE INFORMATION CARD

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NEW PRODUCTS

On the TR-RW490 both transports can record, allowing the user to make simultaneous recordings of the same source. Sequential recording to one cassette after the other increases recording time to three hours when two 90-minute cassettes are used.

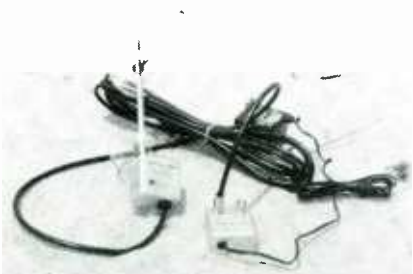
The Model TA-RW470 uses a real-time tape counter for the record/playback transport, providing accurate elapsed and remaining times for all popular cassette lengths. That feature is particularly useful when editing. The TA-RW490 has two fully-independent real-time counters to complement its dual-record capability.

The TA-RW490's computer-controlled synchro-dubbing feature automatically coordinates both transports when transferring material from one tape to the other. The Direct Music Search on both transports skips directly to any song, up to 16 ahead or 15 behind the current location.

The TA-RW470 has a suggested retail price of $500.00; the suggested price of the TA-RW490 is $630.00. For further information contact Onkyo, 200 Williams Drive, Ramsey, NJ 07446.

Glass-Mounted Active Antenna

The *Super Vak-Tenna* provides shortwave listeners and scanner owners with superior performance, easy mounting, and compact size in one antenna. It mounts to glass surfaces by means of two powerful suction cups, making it convenient for use in an apartment or while traveling.



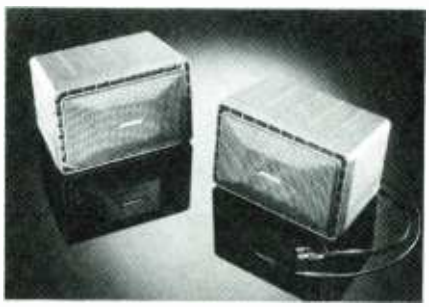
CIRCLE 48 ON FREE INFORMATION CARD

A full 15 feet of coax cable is provided between the antenna and the power unit, to aid in installation. The Super Vak-Tenna is powered by 110 VAC. A female BNC jack is provided for connection to a receiver. The receive-only antenna continuously covers from 500 kHz to 800 MHz for reception of UHF and VHF, as well as MF and HF. An internal active amplifier provides a minimum 14-dB signal boost.

The Super Vak-Tenna costs $149.95. A 50-foot extension cable is available for $20.00, and adapters which allow the unit to stand up to 2 inches off the window cost $3.00. For further information, contact *Electron Processing, Inc.*, Sales Department, P.O. Box 708, Medford, NY 11763; Tel. 516-764-9798.

Compact Loudspeaker System

The *Bose RoomMate II* compact high-fidelity loudspeaker system is AC/DC-compatible. It features an AC/DC power jack with a removable AC-power cord for complete portability. The system consists of two full-range Bose speakers, a two-stage active equalization network, distortion-limiting circuitry, and a dual-channel power amplifier, in two 7- × 10- × 7-inch enclosures. The cabinets are light-weight, durable, and temperature resistant for outdoor use.



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The RoomMate II system can be plugged into any sound source with a headphone jack—including CD players, computers, personal stereos, electronic keyboards, and clock radios. With its small size and high-quality sound, the system is a good indoor choice wherever there are space and budget constraints.

The optional Power Pack is a rechargeable battery pack, weighing less than five pounds, that allows the RoomMate II to play at full volume for up to 12 hours on a single charge. It is available with 110-volt, 100-volt, 220-volt, and 240-volt rechargers, and recharges overnight.

The *TB-2* Travel Bag is another option. It is made of weather-repellent pack cloth, and has padded removable inserts and accessory pockets for tapes, CDs, cables, and adaptors. The acoustically transparent Travel Bag protects the system from sand and dirt. Other accessories include a car adaptor, and mounting brackets and clamping arms.

The RoomMate II speaker system, with adaptors and speaker wire, costs $279.00. The Power Pack costs $89.95; the Travel Bag retails for $85.95; the car adaptor is $24.95; and the mounting brackets and flexible clamping arms are $19.95 and $39.95, respectively. For more information, contact Bose Corporation, The Mountain, Framingham, MA 01701.

Digital Multimeters

C.G. Soar's 3200 Series of DMMs uses custom-designed LSI chips to achieve maximum reliability, speed, accuracy, and operating ease. The user simply connects the leads and selects the proper function, and the auto-ranging circuit does the rest.

Each unit features a 32-segment analog LCD display, a high-speed sampling circuit which is much faster than the LCD numerical display. The 3200-count display allows higher resolution than that of conventional 3½-digit DMMs.

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The 3200 series DMMs have such features as range hold, data hold, and an audible continuity/diode test. An adaptor mode, for use with Soar's *9300 Series* adaptors, allows the user to do AC/DC-current measurements, as well as capacitance, temperature, and transistor testing. A 2500-hour battery life is expected with alkaline cells.

The Model 3210 costs $75.00, Model 3220 costs $99.00, and Model 3230 costs $132.00. Further informa-

tion is available from C.G. Soar, Sales Department, 434 Windsor Park Drive, Dayton, OH 45459; Tel. 513-434-6952.

Multifunction A/D I/O Card

The *R714* card for PCs, XTs, ATs, and compatible computers offers 16 analog inputs and 2 analog outputs of 14-bits resolution each. That multifunction-I/O card also has 16 digital inputs and 16 digital outputs, and a 3-channel, programmable-interval timer/counter.

CIRCLE 87 ON FREE INFORMATION CARD

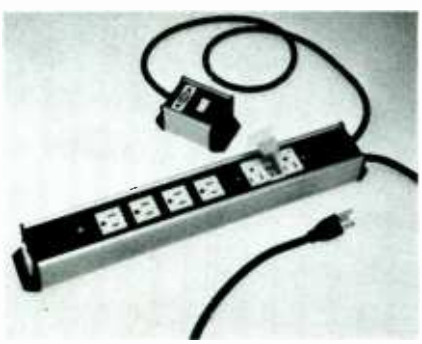
Menu-driven, easy-to-use software—featuring continuous data-recording to disk, display and print functions, start-and-stop time set, scan, and linearization equations for thermocouples—also comes with the R714 card.

The R714, including user manual with sample programs, is available for $995.00 from *Rapid Systems*, 433 North 34th Street, Seattle, WA 98103; Tel. 206-547-8311.

Surge Suppressor

Like light bulbs, surge suppressors eventually burn out—leaving electronic equipment unprotected, with no warning. The *Dragon* surge suppressor offers worry-free protection by immediately sounding an alarm when it has blown. To restore its power, the user plugs in a quick-replacement module, similar to replacing a blown fuse. Instead of replacing the entire strip, individual modules are changed as needed.

The UL-listed Dragon handles 6,000 volts in one billionth of a second, and is rated at 1,800 watts. The basic Dragon



CIRCLE 88 ON FREE INFORMATION CARD

models, with 2 to 4 sockets, cost $79.95 to $89.95. The 6- to 16-socket models come with a remote cord, and cost from $109.95 to $149.95. Replacement modules cost $5.00 each. For more information, contact *Ultima Electronics International Ltd.*, 75 Bi-County Blvd., Farmingdale, NY 11735; Tel. 800-777-8743.

Remote Channel Selection on CB Radio

Midland International's Model 77-158 professional-class citizens-band radio features the *Mic-ro-Tune II* remote channel-selection system. With two-speed up and down buttons on top of the microphone, channel selection is safe and convenient.

Additional channel-selection buttons are located on the radio's front panel, giving the user a choice of standard or remote tuning. ETR-frequency control, with a microprocessor-chip PLL sys-

CIRCLE 89 ON FREE INFORMATION CARD

tem, locks the receiver and transmitter on the desired frequency, and adjusts for temperature and humidity to maintain precise tuning.

The Model 77-158 has RF-gain control—highway and local—to adjust receiver sensitivity and prevent overload from nearby stations. Fully variable microphone-gain control allows maximum range for audio transmissions. Pulse noise from the engine and motor-operated devices is reduced by a switchable noise-elimination system. Heat dissipation is provided by a double-layered RF heat sink, reducing the chances of power-transistor failure. Other features include two-channel memory for instant access to channels 9 and 19, and a large high-intensity LED channel readout.

The Model 77-158 with Mic-ro-Tune II costs $219.00. For more information, contact Midland International, Consumer Communications Division, 1690 North Topping, Kansas City, MO 64120.

(Continued on page 27)

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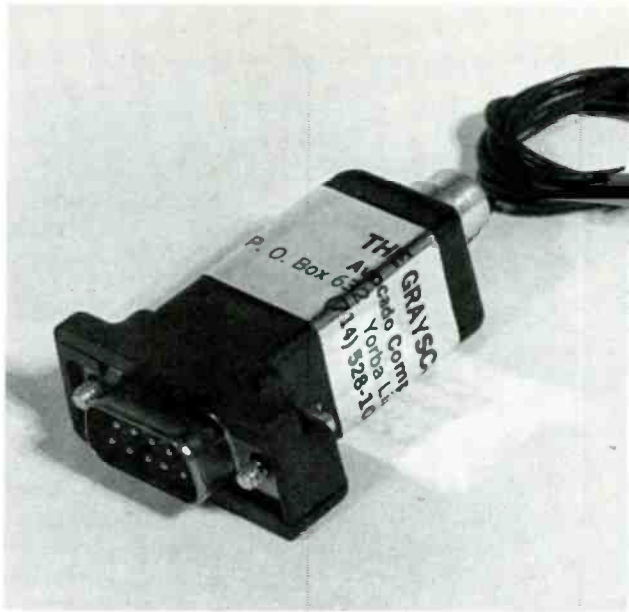
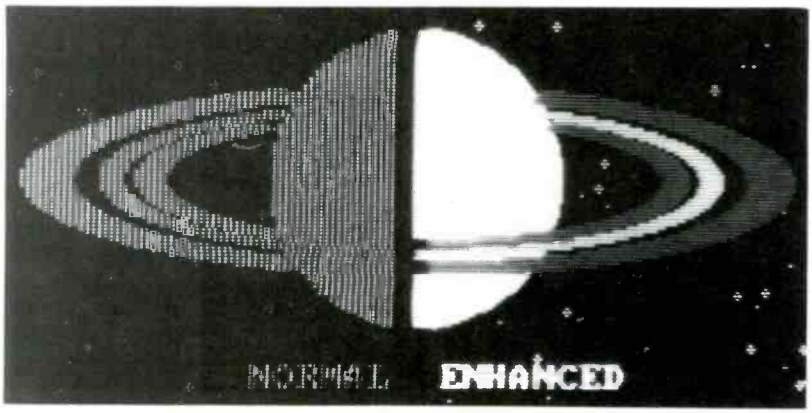
HANDS-ON REPORT

AVOCADO COMPUTER GRAYSCALER

Crisp, composite monochrome with 16 shades of brightness comes alive directly from your color graphics card and RGB port





This is a photo of a screen display showing how a graphics display appears on a composite monitor (left side), and how it appears on the same monitor after processing by the Grayscaler (right side).

IF YOUR BUDGET WAS UP AGAINST THE wall when you got your IBM-compatible computer, it's an odds-on bet that you opted for the color graphics card with a *composite monochrome monitor* because the combination is relatively inexpensive, yet it allows you to run software intended either for the monochrome card with TTL monochrome monitor, or for the color card with RGB (red-green-blue) color monitor. Either way, you saved several hundred dollars.

Unfortunately, the composite monitor is connected to the color graphics card and winds up receiving color information, which creates garbage on the screen of a composite monitor. In fact, of the 16 possible IBM-type colors, twelve create a cross-hatch pattern on a composite monitor, while the remaining four colors merge into the shadow and highlight detail.

Although it is possible to get a "clean" screen display from a color program on a composite monochrome monitor, it can only be done if the software specifically disables the color mode.

As a general rule, a composite monitor can be used with most of the popular software intended for either monochrome or RGB systems—such as *WordStar* for word processing (mono) or *The Print Shop* for signs (color can be automatically disabled by the program)—but if a color program makes no provision for disabling the color information, the display poops out, as shown above.

Shown is a composite photograph of screen displays. The left side is the display provided by a conventional monochrome composite monitor. The right side is how the display appears on the same composite monitor after processing by a special RGB/composite processor called a *Grayscaler*. A Grayscaler is a device that converts a computer's RGB output into an RGB-compatible composite signal, generating a specific brightness level for each of the 16 conventional colors.

How it Works

The conventional composite computer output is the same kind of *analog* signal as used for TV broadcasting and closed-circuit television. Both the monochrome and color information are integrated within the signal. If the monitor is B & W (black and white), the display is monochrome. If the monitor is composite-color, the display is in color. Since the signal contains both monochrome and color elements, it is called a *composite color* signal.

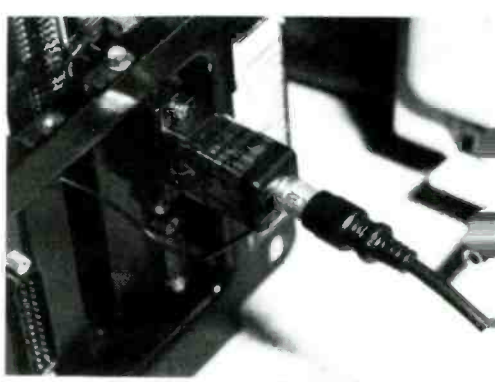
RGB color is something else. The red, blue, green, and intensity (hue) signals are independent *digital* outputs that are integrated into a color display within the monitor itself. The horizontal and vertical sync signals are also independent. If the computer software controls each of the color elements as an independent signal source, it is unlikely they can be interpreted by a composite monitor, and the display is fragmented—a nice way of saying it is "garbage."

On the other hand, the Grayscaler converts the RGBI (Red, Green, Blue, Intensity) digital signals to analog, and integrates the display with the horizontal and vertical sync signals into a composite signal, which then feeds a line driver that provides a low-impedance output for a conventional composite monitor. Even if the program produces what was originally intended as a graphics display, processing by the Grayscaler provides a usable, conventional, composite signal.

A Cubic Inch

The Grayscaler takes up less than 1 cubic inch of space. It plugs directly into the

(Continued on page 100)



The cable from the composite monitor simply plugs into the standard phono-type jack on the rear of the unit.

NEW PRODUCTS

(Continued from page 25)

Medium-Speed Analog Input Board

MetraByte's DAS-8PGA board is an 8-channel, 12-bit analog-input board for the IBM PC/XT/AT and compatibles. The eight differential-input channels offer nine software-selectable input ranges. The DAS-8PGA provides four digital-output bits and three digital-input bits.

A three-channel counter/timer can be used as an A/D-pacer clock, and to measure or generate frequency, measure pulse width, and count events. Complete access to the computer's interrupt bus is available at the board's I/O connector.

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Included with the DAS-8PGA are MetraByte's utility software package and a users manual. The utility software provides a complete assembly driver and installation, calibration, and example programs. A few simple operational data-acquisistion programs are also included. The assembly driver is compatible with both compiled and interpreted BASIC. It performs all the actual board-I/O commands.

The DAS-8PGA costs $560.00. For more information, contact MetraByte Corporation, 440 Myles Standish Blvd., Taunton, MA 02780; Tel. 617-880-3000.

Quad-Section Mesh Antennas

The *CFA T-Lock Plus Model 1131 and Model 1132* quad-section mesh antennas are designed for quick assembly and dependable operation under a wide range of weather conditions. The Model 1131 has buttonhook feed support, and the Model 1132 has quad-pod feed support.

Twenty extruded "T-Lock" support ribs, made of T-5 aircraft aluminum, effectively maintain a precise parabolic curve for a F/D ratio of 0.4. Each antenna panel, made of precision-expanded and rolled aluminum mesh, is preformed to the proper parabolic

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curve prior to installation on handles. The resulting surface is smooth and accurate, delivering a Ku-band gain figure of 47.25 dB.

The CFA T-Lock Plus antennas have a suggested retail price range of $400.00 to $465.00, and are available from *General Instrument Corporation*, VIDEOCIPHER Division, 6262 Lusk Blvd., San Diego, CA 92121.

(Continued on page 103)

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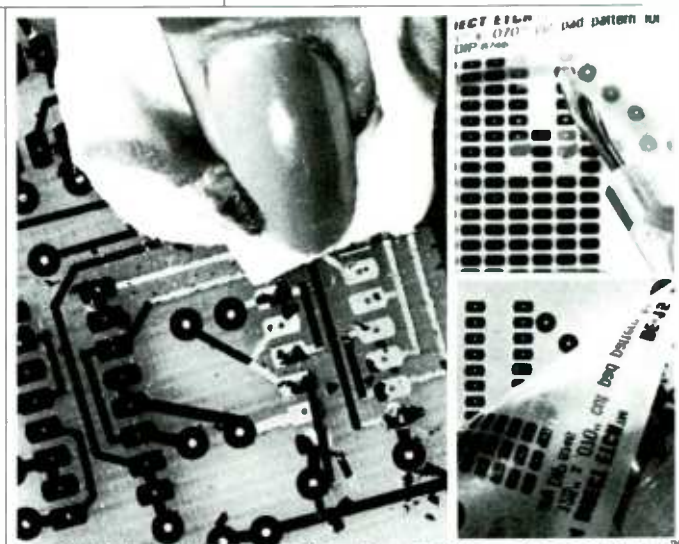

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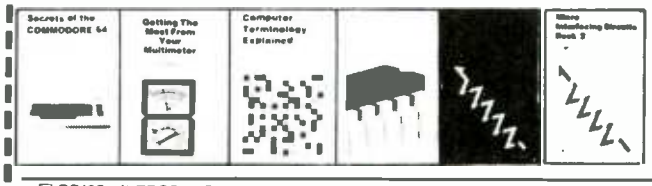

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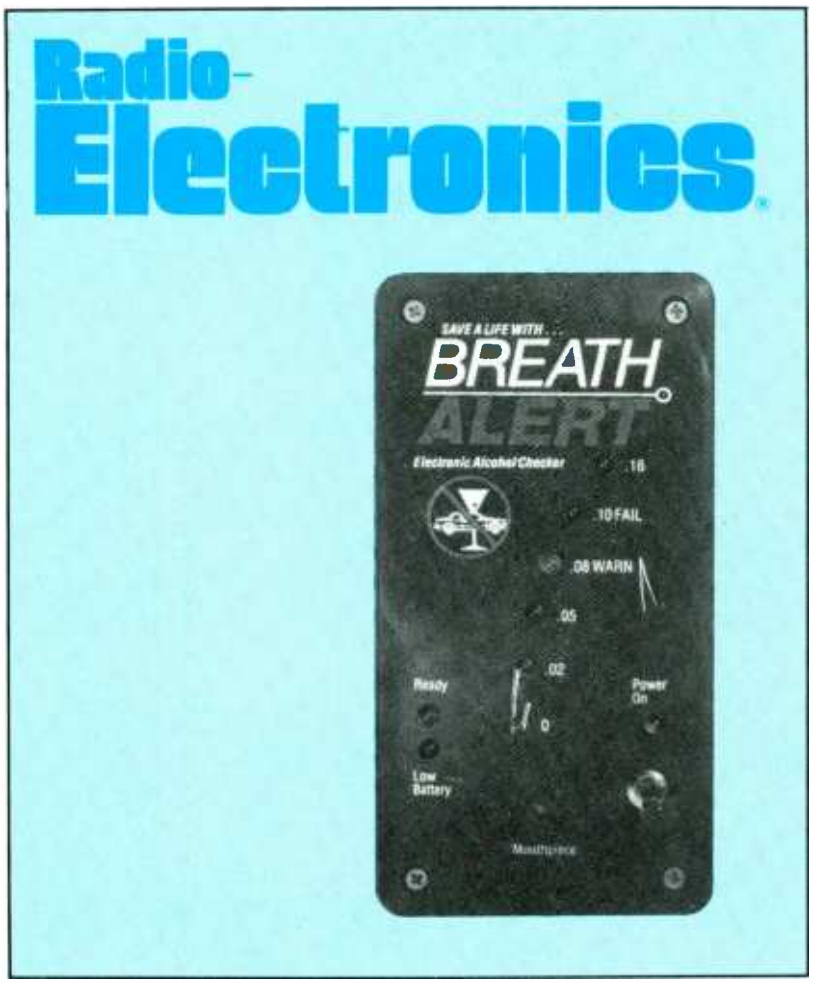

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COMPUTER SPEECH SYNTHESIZER

Give your computer the gift of gab with this easy-to-build, fun-to-use, text-to-speech synthesizer.

By Jeffery Miles

DID YOU EVER WISH THAT YOU COULD MAKE YOUR computer talk without programming it? Would you like to be able to simply type away at the keyboard, hit return, and listen to what you had just typed? Or how about printing a document to the serial port and listening to it instead of reading it? Well, the project described in this article will let you do all of that: It will take ordinary ASCII code and convert it directly into speech!

Text-to-Speech Converter

The project is built around the SPO256-AL2 speech processor and the CTS256-AL2 text-to-speech converter chips manufactured by General Instruments. The circuit is set up to receive standard ASCII code from virtually any microcomputer or dumb terminal that is equipped with an RS-232 port (such as a serial-printer or modem port). If a microcomputer is used, the synthesizer can be activated from a terminal-emulator of any communications program, or from any programming language such as BASIC.

Only two of the lines from the RS-232 serial port are connected to the synthesizer: the transmit data (TD) line (normally line 2), and the signal ground (normally line 7). When a dumb terminal or equivalent is used, lines 2 and 3 on the RS-232 connector should be tied together so that what you type will appear on the terminal's screen.

The CTS256-AL2 is an eight-bit microprocessor with letter-to-sound rules programmed internally in ROM. A pin-out diagram of that integrated circuit is shown in Fig. 1. Those built-in rules allow for translation of ASCII letters and numbers into allophones that are compatible with the SP0256-AL2 speech processor. To determine proper pronunciation, the CTS256-AL2 looks at the placement of the character in relation to the characters that appear before and after.

According to the device's data sheet, the text-to-speech converter is about 85% accurate as far as the proper pronunciation of the word. I was a bit skeptical of that estimate at first. However, after breadboarding and testing the circuit, I found the 85% figure to be quite accurate. I also found that any word could be made to sound correctly if it were spelled phonetically instead of properly. For example: If you enter the word "Don," the voice will say "done;" but if you enter "dawn," then Don will be pronounced correctly.

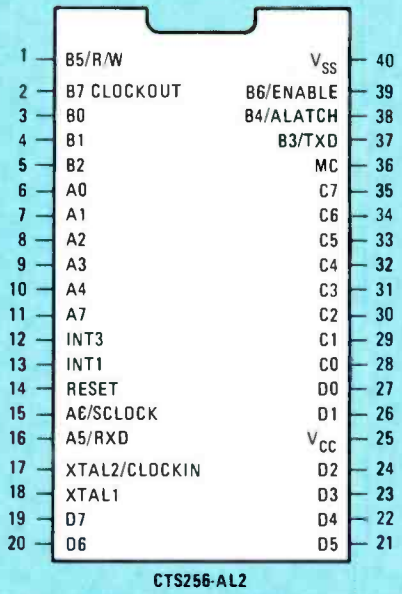


Fig. 1—This is a pin-out diagram of the CTS256-AL2 text-to-speech converter integrated circuit. That device takes the ASCII serial output from a computer or dumb terminal and converts it into allophones that are recognized by the speech synthesizer integrated circuit

The CTS256-AL2 can be configured in a variety of ways. For example, the chip will work with parallel or serial input (with a selectable baud rate), with internal or external RAM, and will output after a carriage return only, or after any non-alphanumeric delimiter. I set the circuit up to work with a serial input because my computer's modem port was free.

I also decided to go with the external-RAM mode and add a memory chip. The internal-RAM input buffer of the CTS256-AL2 will accommodate words 19 characters long, or less, or a phrase of no more than 26 bytes. If you try to send more, the synthesizer will lock up and require resetting. By using the external-RAM, I was able to send just over a screen of text, using my Atari ST, without any problems.

The SPO256-AL2 is a speech processor that requires the parallel input of a code that corresponds to a particular allophone. Those allophones are then linked together to form words. Without the help of the CTS256-AL2, the speech processor must be programmed manually. That can take hours of trial-and-error programming to get even a simple phrase to sound good. A pin-out diagram of the SPO256-AL2 integrated circuit is shown in Fig. 2.

How It Works

The schematic diagram of the speech-synthesizer circuit is shown in Fig. 3. The serial input from the RS-232 port enters the circuit through U7, the MC1489 RS-232-receiver chip, and is converted from an RS-232 level to a TTL-level signal. The CTS256-AL2 chip (U1) then converts the ASCII characters into allophone codes and sends those codes to U3, the TMS4016 external-RAM chip. (Note: If you wish, you can use a 6116LP-3 RAM chip; that chip is pin compatible with the one specified in the schematic diagram.) The codes are then transferred to the SP0256-AL2 (U2) through the 74LS373 octal latch (U4). Finally, the SP0256-AL2 sends out an audio signal to the LM386 audio amplifier (U8)

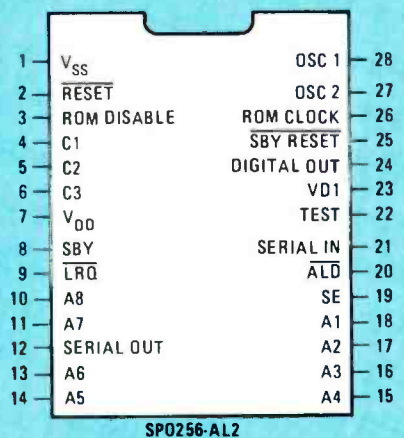


Fig. 2—The SPO256-AL2 takes the allophones output from the text-to-speech converter and converts it into speech. A pin-out diagram of that device is shown in this figure.

PARTS LIST FOR THE SPEECH CONVERTER

SEMICONDUCTORS

U1—CTS256-AL2 text-to-speech converter, integrated circuit (Radio Shack 276-1786)
U2—SP0256-AL2 voice-synthesizer, integrated circuit (Radio Shack 276-1784)
U3—TMS4016-25 or 6116LP-3, 16K static-RAM, integrated circuit
U4—74LS373 octal-latch integrated circuit
U5—74LS138 decoder integrated circuit
U6—74LS04 hex-inverter integrated circuit
U7—MC1489, RS232-line receiver, integrated circuit
U8—LM386 audio-amplifier integrated circuit

CAPACITORS

C1—220-μF electrolytic
C2, C3—100-μF, 16 WVDC, electrolytic
C4—10-μF, 16 WVDC, electrolytic
C5—1-μF, 16 WVDC, electrolytic
C6–C9—0.1-μF Mylar
C10, C11—.022-μF Mylar
C12—100-pF ceramic disc
C13–C16—22-pF ceramic disc
C17–C20—3.3-μF tantalum

RESISTORS

(All fixed resistors are ¼-watt, 5% units unless otherwise noted.)
R1–R4—10,000-ohm
R5—270-ohm
R6—10-ohm
R7—100,000-ohm
R8, R9—33,000-ohm
R10—10,000-ohm linear-taper potentiometer

ADDITONAL PARTS AND MATERIALS

S1—SPST normally open pushbutton switch
S2—4-position DIP switch
SPKR1—8-ohm speaker
XTAL1—10-MHz crystal
XTAL2—3.12-MHz crystal
Printed-circuit board, cabinet, RS-232 connector, 22- or 44- contact card-edge connector (optional), IC sockets, power connector, wire, solder, etc.

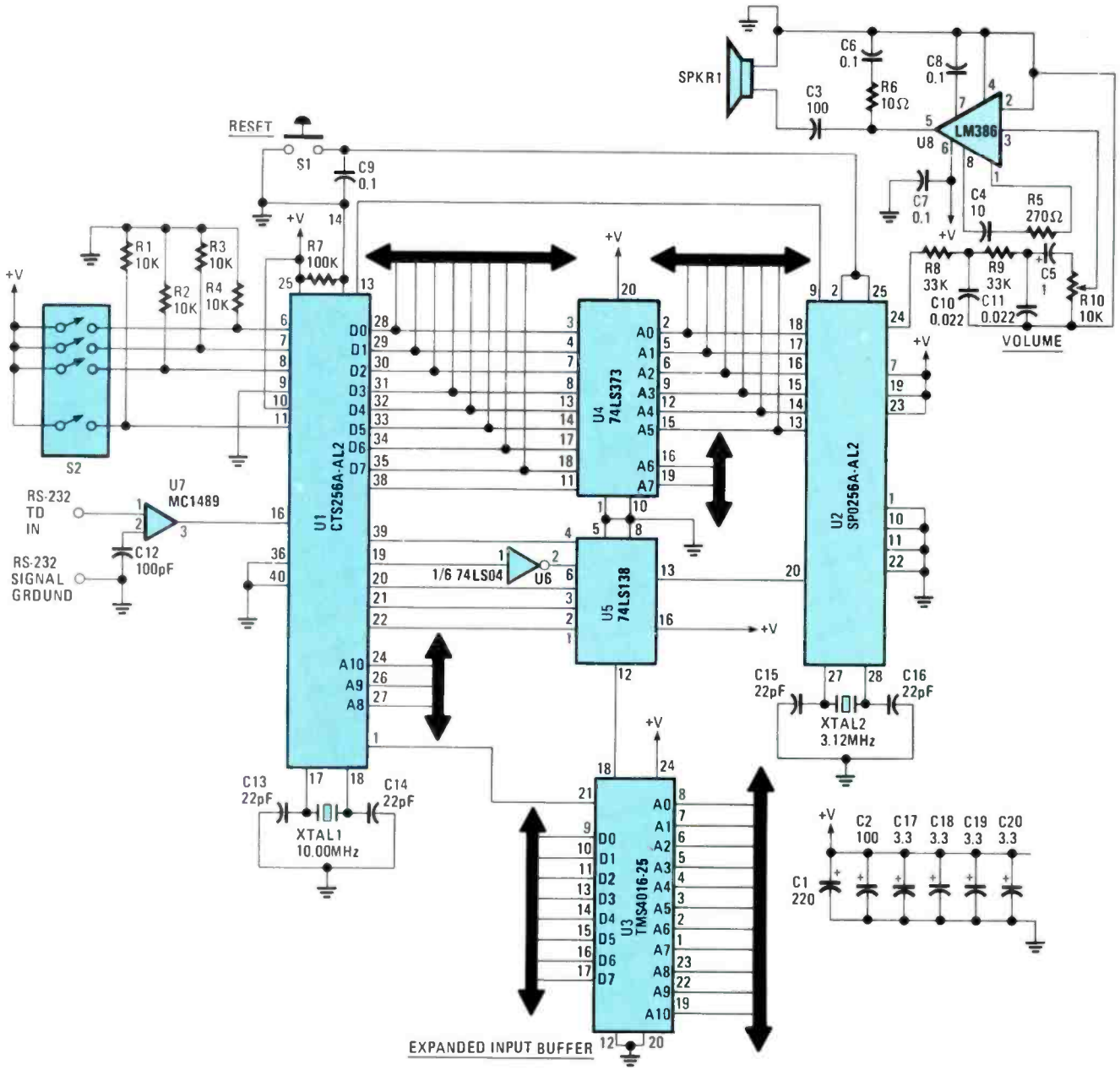


Fig. 3—The computer voice synthesizer will accept the output from any RS-232 port and convert it into easily understood speech. The RAM buffer allows inputs as large as a full screen of text to be accepted. Note that for simplicity, the power and ground connections for U6 and U7 are not shown here.

through some high-pass filtering, and on to the speaker. The 74LS138 (U5) and the 74LS04 (U6) provide control logic.

The prototype was housed in a home-made cabinet made from aluminum sheet metal. If you choose not to go to so much trouble, there are many ready-made cabinets on the market.

Construction

The circuit can be built on a piece of perforated construction board or on a printed-circuit board. If you choose to go the printed-circuit board route, an appropriate pattern is shown in Fig. 4. Note that for space reasons, it was necessary to show the board at half its actual size.

A parts-placement pattern is shown in Fig. 5. Note that, unlike many digital projects, the printed-circuit pattern is single sided. That makes the job of transferring the pattern to the board much simpler. Unfortunately, it also requires the use of an unusually high number of jumpers (26 in all). Make sure all are installed or the project will not work. The use of sockets for all of the integrated circuits is strongly recommended. A pin-out listing of the card-edge connections is shown in Table 1.

After assembling the circuit, triple check for correct placement of components, wires, and for solder bridges, etc.

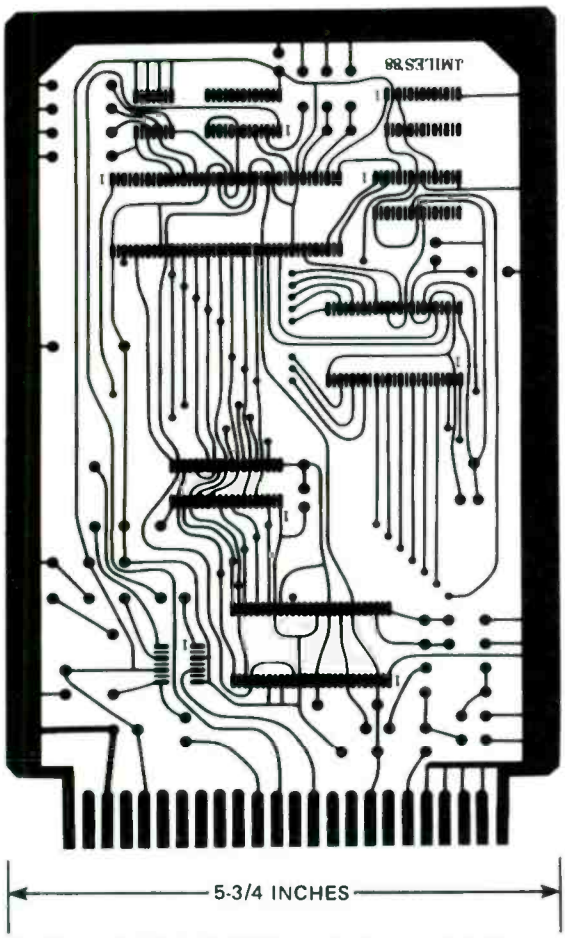


Fig. 4—If you decide to build the project on a printed-circuit board, use this pattern. Note that for space reasons, the board is shown here at half its actual size.

Then, and only then, connect a regulated five-volt supply to the circuit. If all is well, the circuit will say "Okay," indicating that it is ready to receive data. The circuit will say "Okay" every time you power up or hit the reset button.

If you get no response, what can I say? You did something wrong! Go back and re-check your work and correct the mistake. If the voice does say "Okay," then congratulations, you did well!

Finishing Touches

The cabinet shown in the photos is, of course, optional. However, it does make a nice enclosure for the project should you choose to build the PC-board version. I used aluminum sheet-metal and built it from scratch. If you are not so ambitious, you may choose to enclose the project in one of the many commercially available cabinets. Whatever cabinet you choose to use, be sure that you select one that is large enough to accommodate your board and the off-board panel-mounted components.

The method used to mount the board in the cabinet is left to

TABLE 1
CARD EDGE CONNECTOR FINGERS

Finger Number	Connection
2	To Ground
4	To +5 Volts
10	To Speaker (SPKR1)
11	To RS-232 (Transmitted Data, Pin 2)
13	To R10 (Wiper)
16	To S1
18	To R10
19	To RS-232 (Signal Ground, Pin 7)
20	To S1 (Ground)
21	To Speaker (Ground)
22	To R10 (Ground)

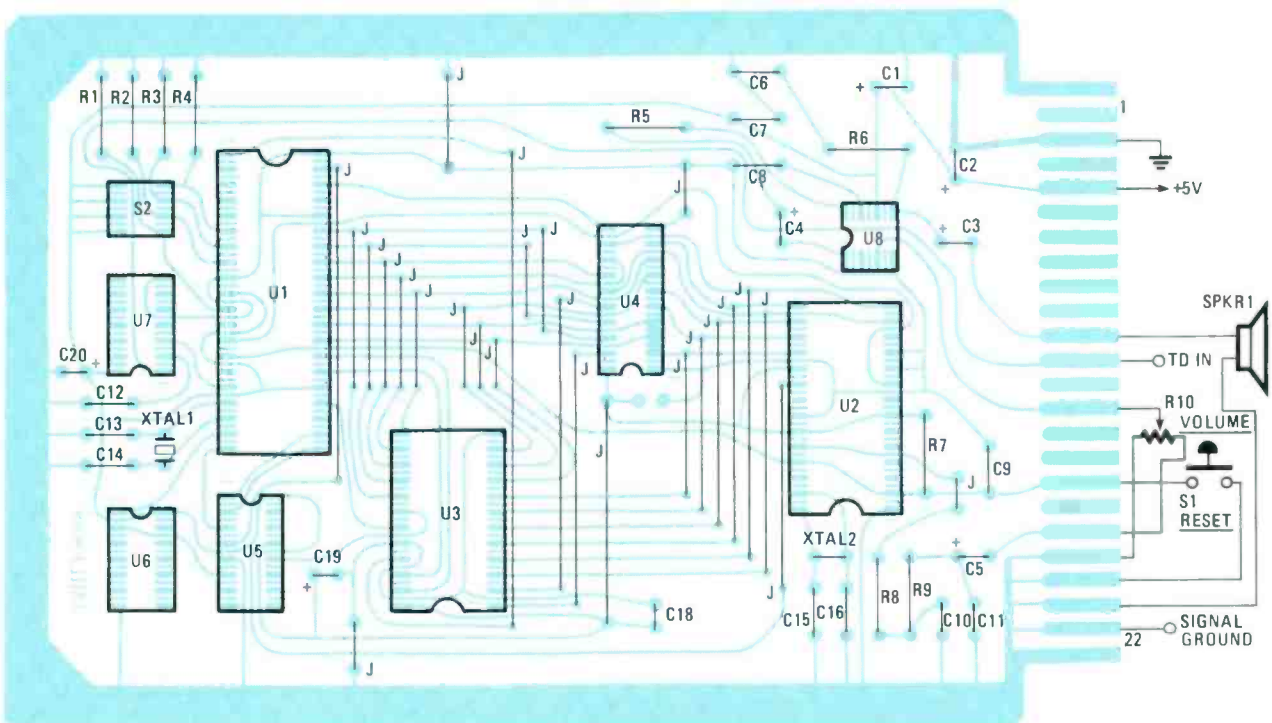


Fig. 5—Mount the components on the printed-circuit board following this layout. Note that the board is single sided. While that means that the board is easier to make, it also means that an unusually high number of jumpers must be installed. Be sure that all of the jumpers shown are installed, or the circuit will not work.

the builder. In the prototype, a 22- (or 44-) contact card-edge connector is mounted in a home-made, right-angle bracket that is secured to the bottom of the case. The board is inserted into the connector, and supported at the other end with non-conductive stand-offs. A less-elegant but still-acceptable mounting technique would be to support the board on four non-conductive stand-offs and tack solder the board-finger connections.

The prototype shown features some extras that are not included in the schematic. Those are an on-off toggle switch, a power-on LED indicator, and an external speaker jack. Those extras are easy to add, so we'll leave the details to the reader. It's also a good idea to insert a fuse in the line between the project and the power supply.

Speaking about the power supply, it is important to use one that is well regulated. Computer-grade 5-volt supplies are ideal for that; they are readily available and are relatively low in cost. The prototype makes use of a surplus Colecovision video-game wall-plug supply.

Set Up and Use

The first step is to set the four-position DIP switch, S2, to match your configuration. Table 2 shows the proper settings for the switches for different set-ups. For instance, if you are using the serial port, and are sending at 1200 baud, switches S2-a, S2-b, and S2-c should be set on, off, and on, respectively. Switch S2-d is used to determine the type of delimiter (separator) that will be used. With switch S2-d set to off, the circuit will speak (output) when you hit a carriage return. If that switch is set to on, the circuit will speak each time you hit the space bar, or type a period or any other non-letter or non-number character.

The easiest way to use the project is to load your communications (modem) program and enter its terminal-emulator mode. Then just type away on your keyboard and listen to your words over the speaker.

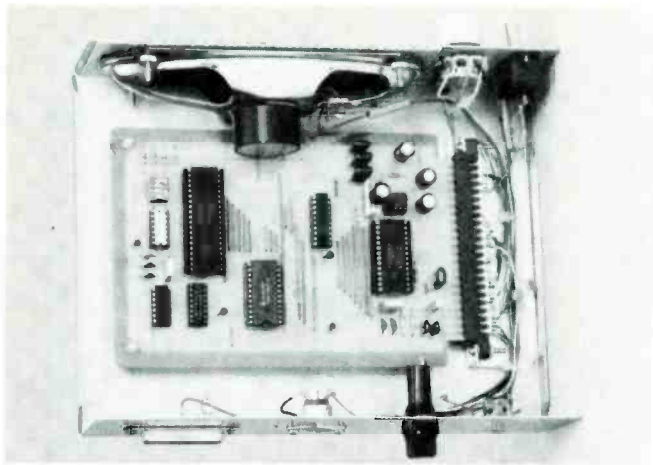
If you want to address the circuit from BASIC, there's a sample program in Listing 1. That program is written in GFA BASIC for the Atari ST, which is the machine that I own. It will have to be modified to run under other variations of BASIC.

What the program basically does is take the left character of an input string and convert it to ASCII, send the ASCII code to the serial port, subtract it from the string, repeat the process until all of the string characters have been sent, and then send a carriage return. I have found that sort of programming most useful for children's educational programs, such as spelling-practice programs. It also adds spice to computer games.

TABLE 2
DIP SWITCH FUNCTIONS

Mode Selection Switch			Mode
1	2	3	
Off	Off	Off	Parallel Input Mode
Off	Off	On	Serial Mode, 50 Baud
Off	On	Off	Serial Mode, 110 Baud
Off	On	On	Serial Mode, 300 Baud
On	Off	Off	Serial Mode, 1200 Baud
On	Off	On	Serial Mode, 2400 Baud
On	On	Off	Serial Mode, 4800 Baud
On	On	On	Serial Mode, 9600 Baud

4	
Off	Carriage-Return-Only Delimiter
On	Any Delimiter



Inside the author's prototype. The author used a card-edge connector mounted on a home-made right-angle bracket to secure one side of the board; the other is mounted on non-conductive stand-offs. While the card-edge connector allows easy wiring to the off-board components, many other mounting schemes are also acceptable and should work just as well.

LISTING 1

```
Start:                  'Program marker
Input A$                'Input a phrase
Do                      'The beginning of a loop
  C=Len(A$)             'C-the length of A$
  If C=0 Then           'If A$ has all been sent, then
    Out 1,13            'Send a carriage return
  Endif                 'End of if/then statement
  Exit If C=0           'If A$ has all been sent,
                        ' then exit the loop
  B$=Left$ (A$)         'B$ is assigned the left
                        ' character of A$
  Out 1,Asc(B$)         'The ASCII value of B$ is output
                        ' to the serial port
  A$=Right$(A$,C-1)     'A$-A$ less its left character
Loop                    'The end of a loop
Goto Start              'Goto the beginning and start over
```

The synthesizer is great entertainment for company. Simply write a dialog program and then pretend to be carrying on a conversation with the computer. Your friends will be amazed that your computer is so intelligent! I have also compiled programs and set them up to run at boot time so that the computer greets me when I turn it on, asks me for a password, etc.

The converter chip that the project is built around does a nice job with single letters and numbers. For example, send it a "7" and the voice says "seven," send it an "R" and the voice says "are," etc. It will not, however, handle a long number. If you send a "609" it will say "six, zero, nine" and *not* "six hundred nine." The chip is also great for sound effects. Send it a long string of "ss ss ss ss ss" and it sounds like a steam locomotive; send "bb bb bb bb bb bb" and you get a machine gun effect. With a little imagination and experimentation, you're sure to come up with many other interesting sound effects.

I have mentioned only a few of the numerous applications for the circuit. If you have any external monitor or control hardware attached to your computer such as a burglar alarm, a fire alarm, a real-time clock, a model-railroad control, etc., then this addition to your system will be great for alerts, warnings, or just plain fun! ■

SOLID-STATE TESLA COIL

Build an updated version of Nikola Tesla's most-famous experiment.

By Charles D. Rakes

NIKOLA TESLA IS CONSIDERED BY SOME TO BE THE greatest inventor of our modern electrical age, and many experts consider him to be the true father of radio. However, today he is best remembered for his fascinating wireless power-transmission experiments, using his famous Tesla coil.

The high-frequency air-core, oscillating Tesla coil is just as exciting today as it was back in 1899, when he used it to successfully transmit electrical energy over 25 miles, without wires, to light a large number of incandescent lamps. The Tesla coil is ideal for demonstrating and exploring the unusual phenomena that occur with high-frequency high-voltage energy.

Most Tesla coils designed for educational and experimental purposes use a line-operated, step-up transformer—in setups like that shown in Fig. 1—to generate the high voltage needed for the coil's primary circuit. While there's nothing technically wrong with that approach, it can place the operator in harm's way if the coil's primary circuit is accidentally touched. A shock from the high-voltage winding could prove extremely dangerous and may be fatal.

Our version, the *Solid-State Tesla Coil* (see photos), eliminates the line-operated, high-voltage transformer, making it a safer project to build and to experiment with. Even so, wise operators will keep their digits out of the wiring while the coil is under power.

Solid-State Tesla Coil

The schematic diagram for the Solid-State Tesla Coil is shown in Fig. 2. In that updated version of the Tesla experiment, an 18-volt, 2-ampere transformer (T1), a bridge rectifier circuit (consisting of D1-D4), and filter capacitors (C1 and C3) supply operating power for the coil circuitry.

A 555 oscillator/timer (U1) is configured as a self-oscillating pulse-generator circuit. Resistors R1 and R2 make up a voltage-divider network, which is used to lower the 24-volt DC output of the power supply to a safe operating level for U1. The 555's narrow output pulse at pin 3 supplies drive current to the base of Q1. Transistor Q2 supplies sufficient

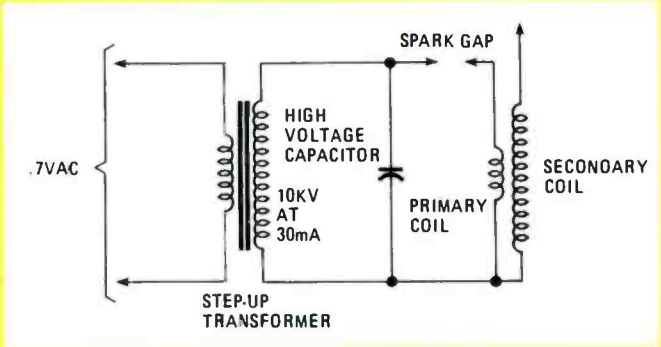
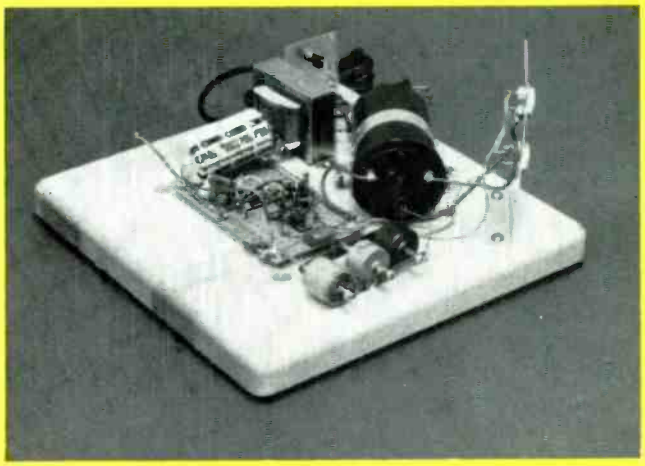


Fig. 1—Shown here is a basic design for a Tesla Coil circuit, using a line-operated, step-up transformer to generate the high voltage needed for the coil's primary.



Here is the author's prototype of the Solid-State Tesla Coil with the 9-inch circular deck removed. The two heavy wires running the length of the top and bottom of the board serve as the ground and +V bus.

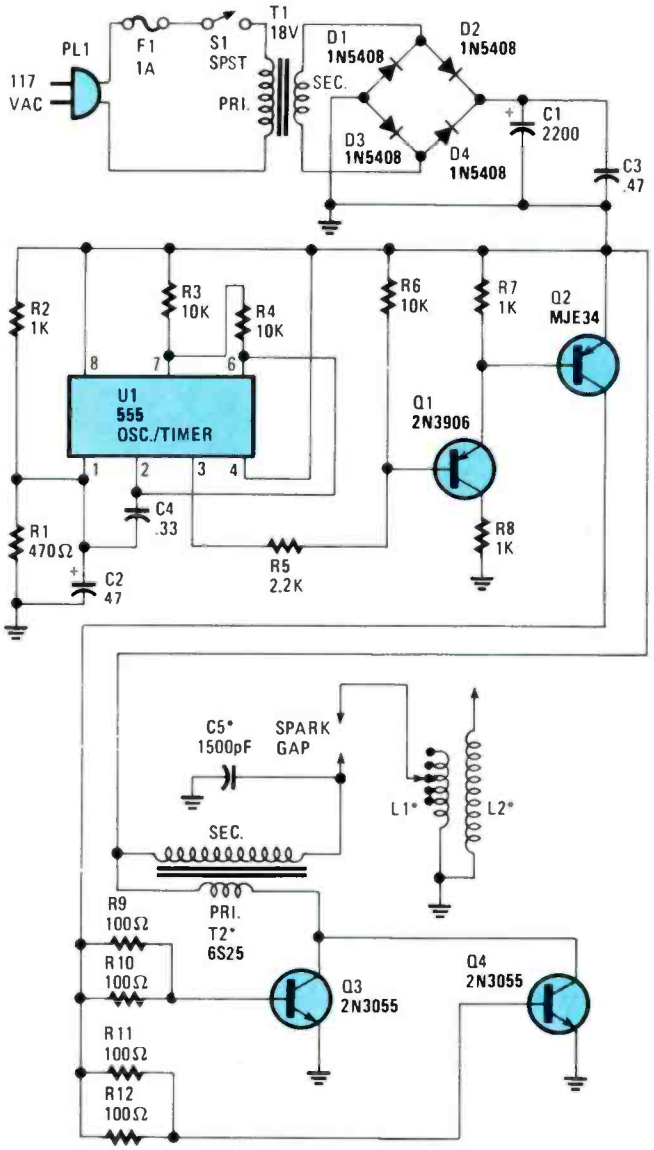


Fig. 2—Our updated version of the Tesla experiment uses an 18-volt, 2-ampere transformer (T1), a full-wave bridge rectifier (consisting of D1-D4), and filter capacitors (C1 and C3) to supply operating power for the Coil's circuitry.

current to transistors Q3 and Q4 to drive those components into full saturation.

The primary winding of T2 (an automobile-ignition coil) is connected in series with Q3 and Q4, and across the power supply. Transistors Q3 and Q4 operate like a toggle switch, connecting the coil across the power source at the rate and on-time set by U1.

That high-current pulse generates a rising and collapsing field across the primary winding of T2. The field causes a current to be induced in the secondary winding of T2. The secondary output of T2 is fed across three 500-pF, 10-kilovolt doorknob capacitors (collectively designated C5) that are parallel connected and tied across the high-voltage output of T2 as an energy-storage device. Those capacitors charge up to T1's secondary voltage and are then discharged through the spark gap and the primary (L1) of the Tesla coil, producing higher voltage in the secondary of the coil (L2).

The secret of producing a successful Tesla coil is in the tuning of the primary coil to the natural resonance frequency of the secondary coil. Because variable 10-kilovolt capacitors are about as common as Condor eggs, some other means must be used to tune L1. The simplest method is to tap the primary coil on every turn and select the tap that produces the greatest voltage at the hot end of L2.

Perfboard Assembly

The author's prototype was built breadboard style on an 11 × 11 × 1-inch wooden cutting board (see photos), but any similar non-conducting material (perhaps plastic) will do. The majority of the small components, as shown in the photos, were mounted on a 3 × 5-inch section of perfboard, and point-to-point wiring techniques were used to complete the connections. Refer to the schematic diagram (in Fig. 2) and the photos for wiring and general parts-layout details. Note: Components T1 and T2, C5, Q3 and Q4, F1, and S1 are not mounted to the perfboard (see photos).

Figure 3 shows the positioning of the perfboard and off-board components on the baseboard. Mount the fully-populated perfboard assembly to the baseboard using four ¼-inch plastic spacers and wood screws. The location of the sub-assemblies on the baseboard isn't too critical, so long as the general layout is followed. Keep all wire leads as short as possible, especially around the high-voltage circuitry.

A 2½ × 2-inch piece of aluminum is formed into an "L" bracket, which is used to hold S1 and F1 (see photo), and is mounted on one corner of the baseboard. A 5 × 3-inch piece of aluminum mounts to the opposite corner and functions as the heat sink for the two power transistors (Q3 and Q4). A simple band is formed from aluminum to hold T2 in place.

Recall that C5 is really three 500-μF doorknob capacitors.

PARTS LIST FOR THE SOLID-STATE TESLA COIL

SEMICONDUCTORS

U1—555 oscillator/timer, integrated circuit
Q1—2N3906 general-purpose PNP silicon transistor
Q2—MJE34, ECG197 (or similar) audio-frequency PNP sllicon power transistor
Q3, Q4—2N3055 NPN silicon power transistor
D1-D4—1N5408 3A, 100-PIV silicon rectifier diode

RESISTORS

(All resistors are ½-watt, 5% units, unless otherwise noted.)
R1—470-ohm
R2, R7, R8—1000-ohm
R3, R4, R6—10,000-ohm
R5—2200-ohm
R9–R12—100-ohm, 1-watt resistor

CAPACITORS

C1—2200-μF, 50-WVDC electrolytic
C2—47-μF, 25-WVDC electrolytic
C3—0.47-μF, 100-WVDC mylar
C4—0.33-μF, 100-WVDC mylar
C5—1500-pF, 10K-WVDC (three parallel-connected 500-pF doorknob capacitors, see text)

ADDITIONAL PARTS AND MATERIALS

F1—1-ampere fuse, 3AG
L1, L2—see text
S1—SPST miniature toggle switch
T1—117-volt primary, 18-volt 2-ampere secondary stepdown transformer
T2—Automobile-ignition coil (Ford #6S25, or similar)
Perfboard, #12 wire, #26 wire, aluminum, Fahnestock clips, spacers, solder, hardware, etc.

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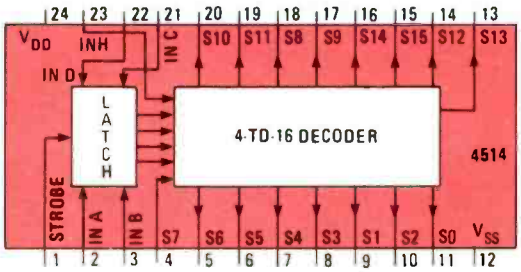
85 Hands-on Electronics FactCard — 4514: 4-Bit Latch/4-To-16 Line Decoder



FEATURES

- Wide supply voltage range — 3.0V to 15V
- High noise immunity — 0.45 V_{DD} (typ.)
- Low power TTL compatibility — fan out of 2 driving 74L
- Low quiescent power dissipation — 0.025 µW/package @ 5.0V_{DC}
- Single supply operation
- Input Impedance = 10^{12} Ω typically
- Plug-in replacement for MC14514, MC14515

ABSOLUTE MAXIMUM RATINGS

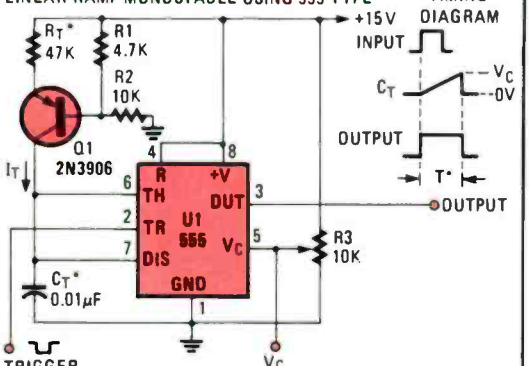
V_{DD} DC Supply Voltage	−0.5V to +18V
V_{IN} Input Voltage	−0.5 to V_{DD} + 0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 seconds)	260°C

RECOMMENDED OPERATING CONDITION

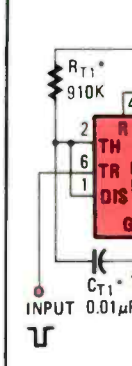
V_{DD} DC Supply Voltage	0 to V_{DD}
V_{IN} Input Voltage	0 to V_{DD}
T_A Operating Temperature Range	
CD4514BM, CD4515BM	−55°C to +125°C
CD4514BC, CD4515BC	−40°C to +85°C

86 Hands-on Electronics FactCard — 555 Circuits

LINEAR-RAMP MONOSTABLE USING 555 TYPE



TIMING DIAGRAM

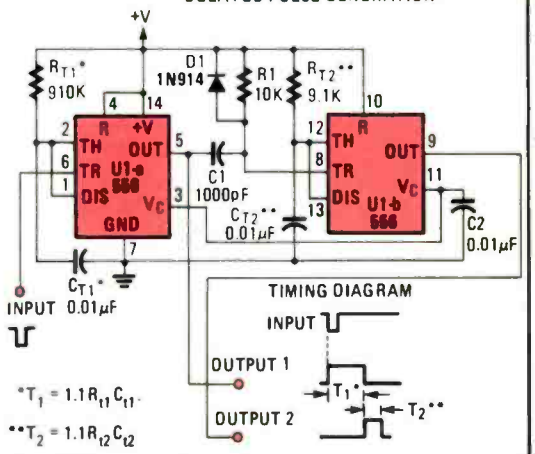


*FOR V+ OF 15V:

$T = \frac{V_C C_T}{I_T}$, $I_T \cong \frac{4.2}{R_T}$ $T \cong 0.24 V_C R_T C_T$

(AS SHOWN, $T_{MAX} \cong 1$ MS WITH $V_C = 10$V.)

DELAYED PULSE GENERATION



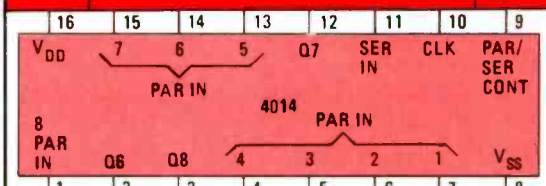
TIMING DIAGRAM

*$T_1 = 1.1 R_{t1} C_{t1}$

**$T_2 = 1.1 R_{t2} C_{t2}$

(AS SHOWN, T_1 = 10 MS; T_2 = 100µS.)

87 Hands-on Electronics FactCard — 4014: 8-Stage Static Shift Register



TRUTH TABLE

CL*	SERIAL INPUT	PARALLEL/SERIAL CONTROL	PL 1	PL n	Q1 (INTERNAL)	Qn
⎍	X	1	0	0	0	0
⎍	X	1	1	0	1	0
⎍	X	1	0	1	0	1
⎍	X	1	1	1	1	1
⎍	0	0	X	X	0	Q_{n-1}
⎍	1	0	X	X	1	Q_{n-1}
⎍	X	X	X	X	Q1	Q_n

*LEVEL CHANGE — NO CHARGE

X = DON'T CARE CASE

FEATURES

- Wide supply voltage range—3.0V to 15V
- High noise immunity—0.45 V_{DD} (typ.)
- Low power TTL compatibility—fan out of 2 driving 74L or 1 driving 74LS
- 5V-10V-15V parametric ratings
- Symmetrical output characteristics
- Maximum input leakage 1 µA at 15V over full temperature range

ABSOLUTE MAXIMUM RATINGS

V_{DD} Supply Voltage	−0.5 to +18V
V_{IN} Input Voltage	−0.5 to V_{DD} +0.5V
T_S Storage Temperature Range	−65°C to +150°C
P_D Package Dissipation	500 mW
T_L Lead Temperature (Soldering, 10 sec.)	260°C

RECOMMENDED OPERATING CONDITIONS

V_{DD} Supply Voltage	3.0 to 15V
V_{IN} Input Voltage	0 to V_{DD}
T_A Operating Temperature Range	
CD4014BM	−55°C to +125°C
CD4014BC	40°C to 85°C

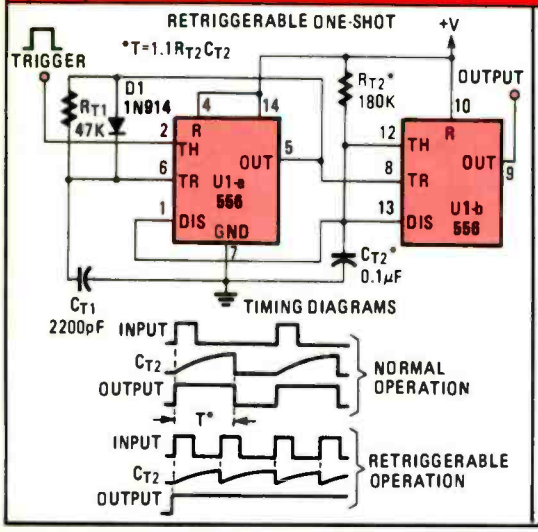
85 Hands-on Electronics FactCard — 4514: 4-Bit Latch/ 4-To-16 Line Decoder

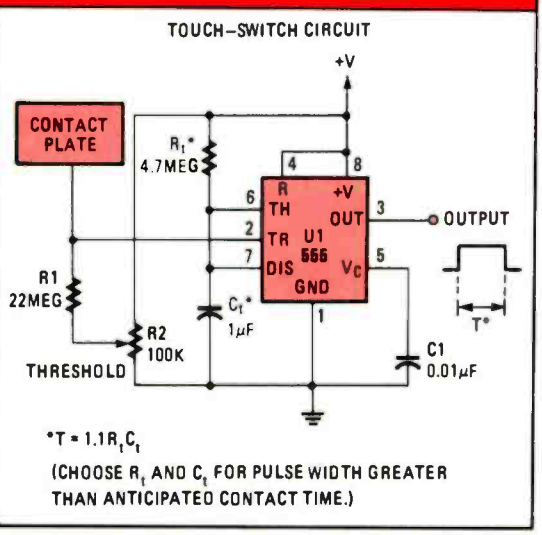
STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMITS at 25°C (Typ.)	UNITS
Quiescent Device Current, I_{DD} Max.	—	0,5	5	0.04	µA
	—	0,10	10	0.04	
	—	0,15	15	0.04	
	—	0,20	20	0.08	
Output Low (Sink) Current I_{OL} 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_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMITS at 25°C (Typ.)	UNITS
Output Voltage: Low-Level, V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage: High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	0.5,4.5	—	5	—	V
	1,9	—	10	—	
	1.5,13.5	—	15	—	
Input High Voltage, V_{IH} Min.	0.5,4.5	—	5	—	
	1,9	—	10	—	
	1.5,13.5	—	15	—	

86 Hands-on Electronics FactCard — 555 Circuits





87 Hands-on Electronics FactCard — 4014: 8-Stage Static Shift Register

STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMITS at 25°C (Typ.)	UNITS
Quiescent Device Current, I_{DD} Max.	—	0,5	5	0.04	µA
	—	0,10	10	0.04	
	—	0,15	15	0.04	
	—	0,20	20	0.08	
Output Low (Sink) Current I_{OL} 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_{OH} Min.	4.6	0,5	5	−1	
	2.5	0,5	5	−3.2	
	9.5	0,10	10	−2.6	
	13.5	0,15	15	−6.8	
Input Current I_{IN} Max.	—	0,18	18	$\pm 10^{-5}$	µA

CHARACTERISTIC	CONDITIONS V_O (V)	V_{IN} (V)	V_{DD} (V)	LIMITS at 25°C (Typ.)	UNITS
Output Voltage: Low-Level, V_{OL} Max.	—	0,5	5	0	V
	—	0,10	10	0	
	—	0,15	15	0	
Output Voltage: High-Level, V_{OH} Min.	—	0,5	5	5	
	—	0,10	10	10	
	—	0,15	15	15	
Input Low Voltage, V_{IL} Max.	0.5,4.5	—	5	—	V
	1,9	—	10	—	
	1.5,13.5	—	15	—	
Input High Voltage, V_{IH} Min.	0.5,4.5	—	5	—	
	1,9	—	10	—	
	1.5,13.5	—	15	—	

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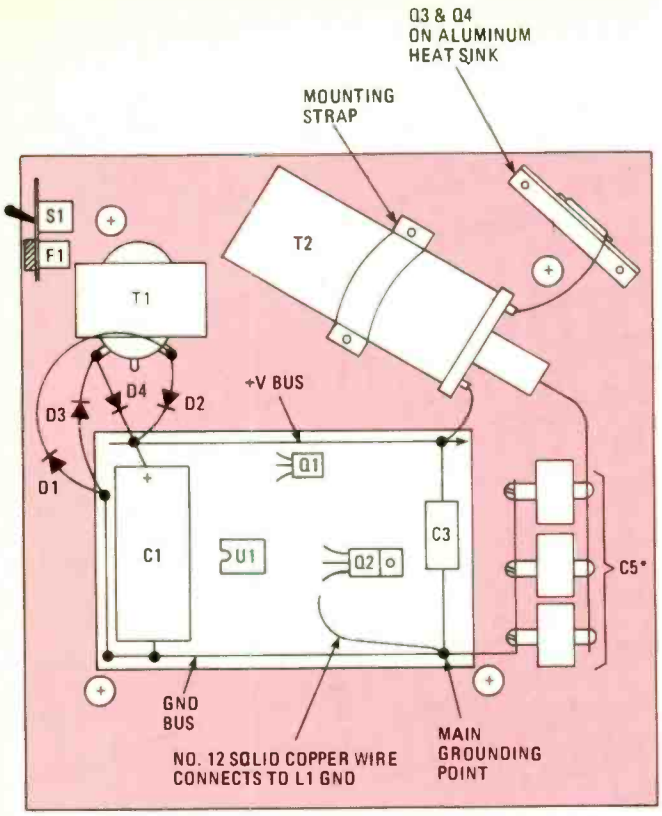
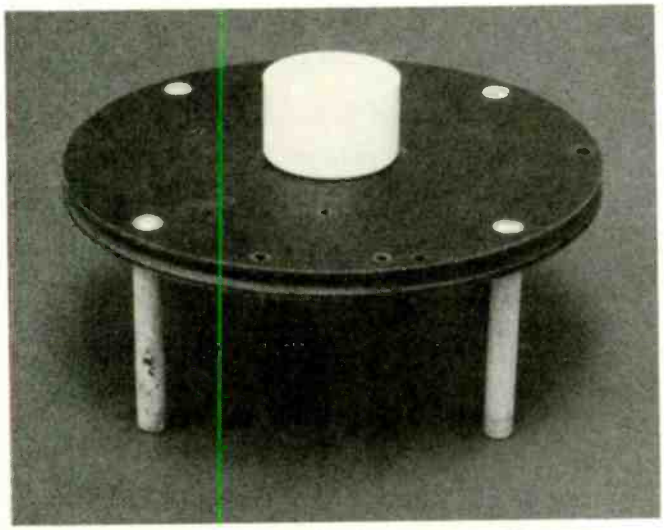


Fig. 3—The author's prototype was built breadboard style on an 11 × 11 × 1-inch wooden cutting board, and most of the components were mounted on a 3 × 5-inch piece of perfboard.

Two brass strips, about ⅜-inch wide by 3-inches long, are used to tie the three high-voltage capacitors together. If doorknob capacitors cannot be located (often they can be salvaged from older black-and-white TV's), a substitute can be made from window glass and aluminum foil.

To fabricate C5, take a 10-inch square piece of glass, like that of a picture frame, and glue a 9-inch square piece of aluminum foil to the center of the glass on both sides, leaving an equal border around each aluminum plate. Cut two 6-inch lengths of #22 insulated stranded wire. Strip about 3-inches of insulation from one end of each wire and tape the stripped end to each of the aluminum plates.



Shown here is the 9-inch circular deck supported by four dowel rods, and an end cap positioned at its center.

The Deck

Figure 4 and the photos show the top deck of the author's prototype, where the two air-core coils (L1 and L2) are mounted. The top deck consists of a 9-inch diameter circle cut from ½-inch thick fiber board. Four 3¾-inch lengths of ⅜-inch dowel hold the 9-inch coil base above the perfboard.

Select a drill bit slightly smaller than the dowel rod's diameter and drill the four mounting holes in the 9-inch circle to match the illustration. Position the 9-inch circle on the baseboard at about the center, and mark the location of each hole. Drill each location on the baseboard with the same bit to a depth of about ½-inch.

If the two-layer Tesla coil seems like too much bother to

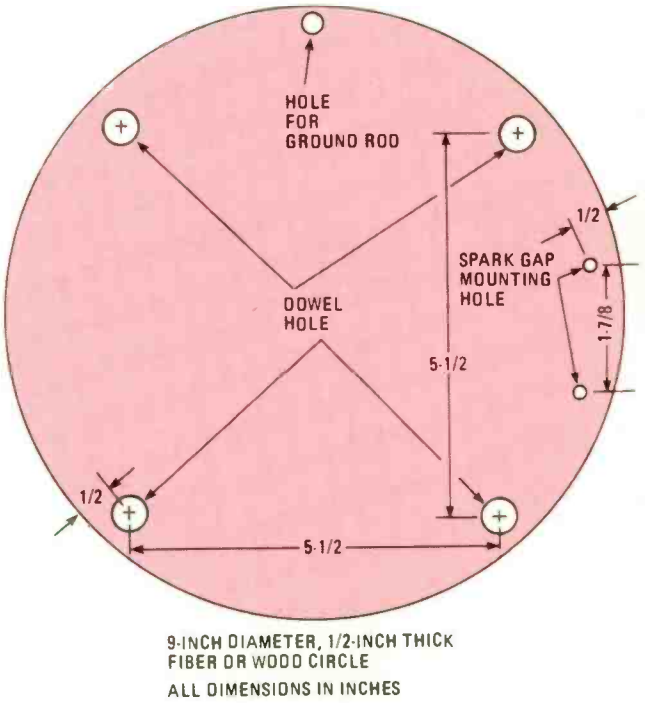
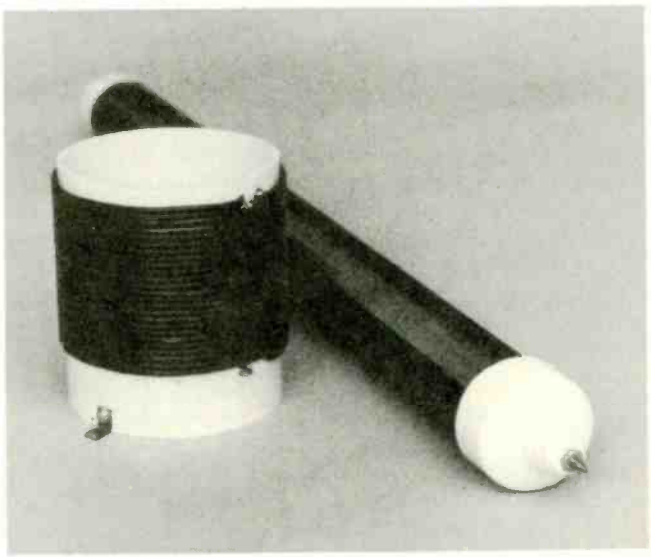


Fig. 4—Shown here is the general layout of the top deck of the author's prototype, which supports coils L1 and L2. Four 3¾ × ⅜-inch wooden dowel rods hold the 9-inch circular base above the perfboard and other components.



Here is what L1 (left) and L2 (right) should look like once completed. Although winding L2 may appear difficult, it can be done in an hour by hand or in 15 minutes by lathe.

duplicate, then build a single-level unit on a larger wooden base to suit your own needs. Actually, any good layout scheme that respects the dangers of high voltage should do quite well.

Winding the Primary Coil

The primary-coil (L1) is wound on a form cut from a 4-inch diameter, plastic sewer pipe to a length of five inches (see Fig. 5). Take a 27-foot piece of #12 insulated solid-copper wire and strip away a ⅛-inch section of insulation at about every 12 inches, continuing for one-half the length of the wire (12 times total). Those stripped areas serve as tap points for tuning the coil.

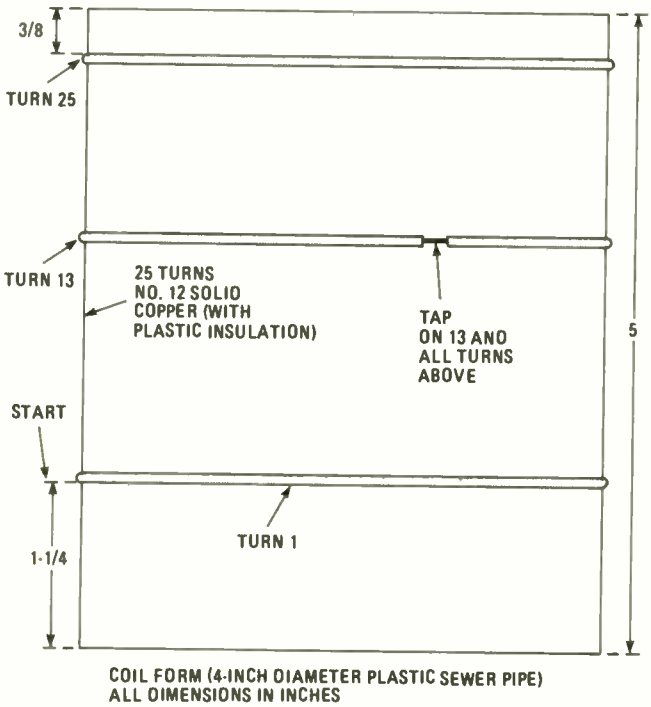


Fig. 5—The form on which L1 is wound is a five-inch length of four-inch diameter, plastic sewer pipe. A 27-foot length of #12 insulated solid copper wire (with 12 quarter-inch sections of insulation stripped away at intervals of about every 12-inches) is then wound onto the form.

Wind the coil starting at the top of the coil form (see Fig. 5) with the end that has the 12 tap points. In other words, turn 25 is the first winding to be made. That gives a tap on every turn from turn number 13 to turn number 25. Drill two small holes in the coil form where the winding starts and ends. Those holes are used to secure the ends of the windings (see photos).

Winding the Secondary Coil

The secondary coil form (see Fig. 6) is cut from a section of 1½-inch diameter, plastic water pipe (which actually measures 1⅞-inches in diameter). So when selecting your secondary coil form, take a ruler with you and be sure to come home with the correct-diameter pipe. You'll also need two plastic end caps that snugly fit the ends of the tubing.

Make a mark on the coil form about one inch from each end. That sets the starting and ending points for the winding. Fill the space between marks with a neat solenoidal winding of #26 enamel-covered copper wire. Winding the coil by hand shouldn't take over an hour, and if a lathe is handy, you should be able to complete the job in about 15 minutes. Leave

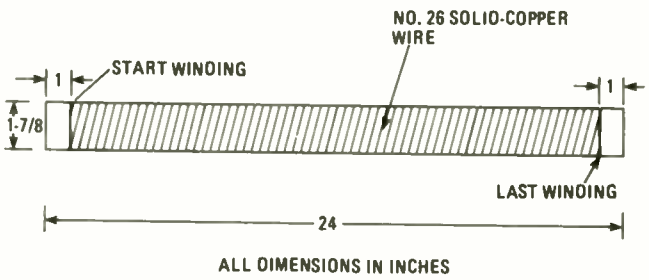


Fig. 6—Using #26 enamel-coated copper wire, L2 is wound on a 24-inch length of 1½-inch diameter, plastic water pipe, either by hand or (if available) using a lathe.

about 6-inches of wire at both ends of the winding for making connections.

Spray several coats of Krylon clear #1301 acrylic on the coil for added insulation and protection against moisture. Always let each coat dry completely before applying the next. Two or three coats are sufficient.

It's Coming Together

Mount one of the 1½-inch, plastic end caps to the center of the 9-inch circular deck with a 1-inch long #8-32 screw, washer, and nut. Take two small metal "L" brackets and mount the primary coil centered around the end cap on the 9-inch base. Drill a small hole through the end cap and baseboard near the rim of the cap. Take the secondary coil and push one end of the coil's lead through the hole in the end cap, and then set the coil in the end cap.

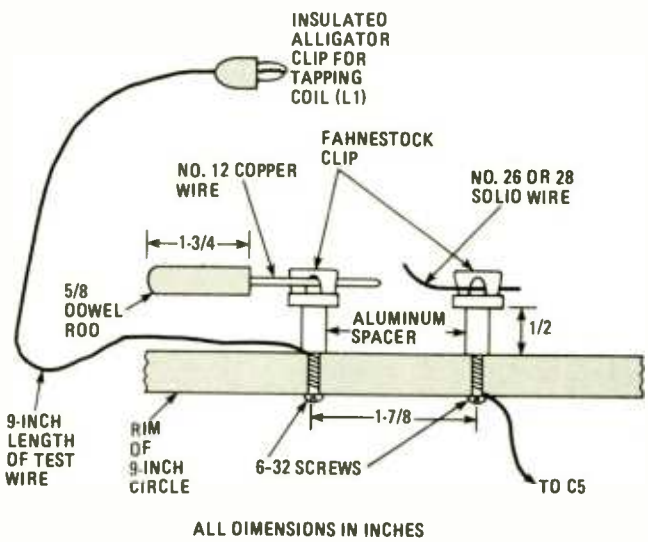
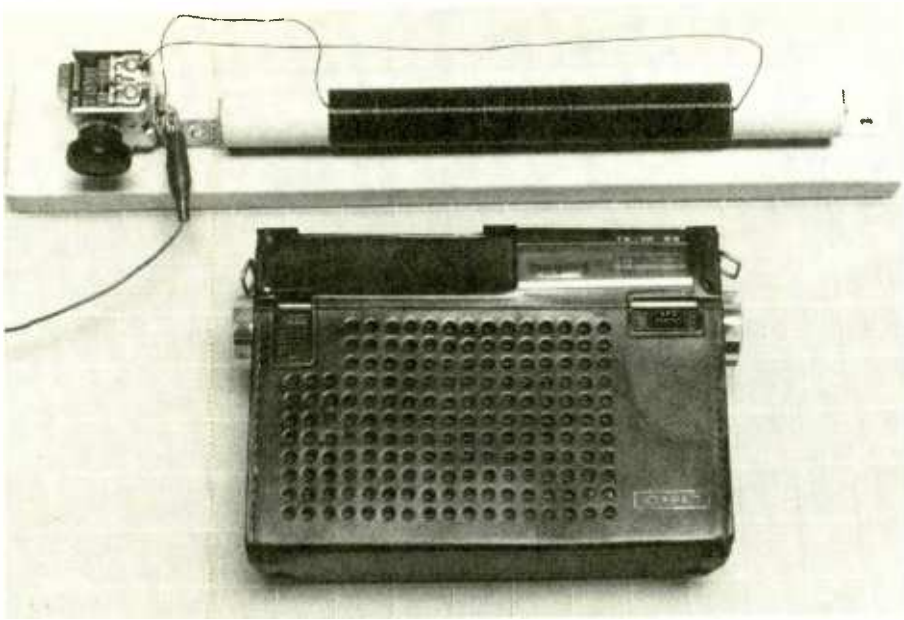


Fig. 7—The spark gap is formed by mounting two fahnestock clips to the 9-inch circular deck; one tied to the main grounding point, and the other connected to an alligator clip, which is used to change taps on L1.

Take the other end cap and drill a hole in the center to clear a #8-32 screw, and mount a feed-through insulator (see photo) on top. Select a #8-32 screw long enough to stick through the top of the insulator by about ½-inch, and grind the end to a nice sharp point. Connect the top end of the secondary coil to the bottom of the #8-32 screw with a small solder lug and tighten in place. Place the cap on top of the coil.

The spark gap is shown in Fig. 7. Two holes are drilled to clear a #6-32 screw to match the drawing in Fig. 4. Two

(Continued on page 102)



BC ANTENNA COUPLER

Zoom in on those distant stations with an external antenna, and you don't even have to wire it up to your radio!

By Larry Lisle, K9KZT

YOU CAN TURN AN ORDINARY AM RADIO INTO A SUPER signal sniffer by adding a good antenna. With a good antenna you can hear those weak, but often times very interesting, stations, such as those operated by many state universities during the day. At night you can hear stations from thousands of miles away—even from overseas!

In the old days most console and table-model radios sported a connection for an external antenna. Today very few receivers have them, but you can still add an external antenna—with the *BC Antenna Coupler*.

How it Works

The BC antenna coupler (see Fig. 1) is simply a parallel-resonant circuit made up of coil L1 and capacitor C1. Signals captured by the antenna are fed to the coupler, where those at the resonant frequency are passed on to the receiver's loopstick antenna coil by inductive coupling with L1. Moving the coupler close to the radio increases the transfer of energy, while backing it off a little will help the selectivity and cut down on interference.

Construction

Building the BC Antenna Coupler is a snap, even if you've never built an electronic project before. The variable capacitor needed for the project can be salvaged from an old radio and is mounted on its side. A brass corner brace is used to secure the capacitor to a 3×16-inch piece of wood. A Fahnstock clip is placed under the screw that attaches the capacitor to the bracket.

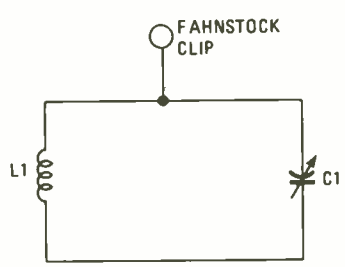


Fig. 1—Believe it or not, this schematic diagram contains all the components you'll need to build the BC Coupler. It can be built from parts you can salvage from any old radio.

PARTS LIST FOR BC ANTENNA COUPLER

C1—365-pF variable capacitor.
L1—Hand-wound coil (see text)

A baseboard 1×3×16 inches; 1-inch diameter dowel; knob to match the capacitor; Fahnstock clip; three brass corner braces; four ½×4-inch wood screws; 30-foot wire for antenna; alligator clip (see text).

The coil is wound on a 1-inch dowel, 11 inches long. Anchor holes are drilled through the rod 2 inches from each end, and the coil is wound between them with #22 enameled wire. Make sure the coil's lead lengths are amply long, and secure the coil to the board with a pair of corner brackets.

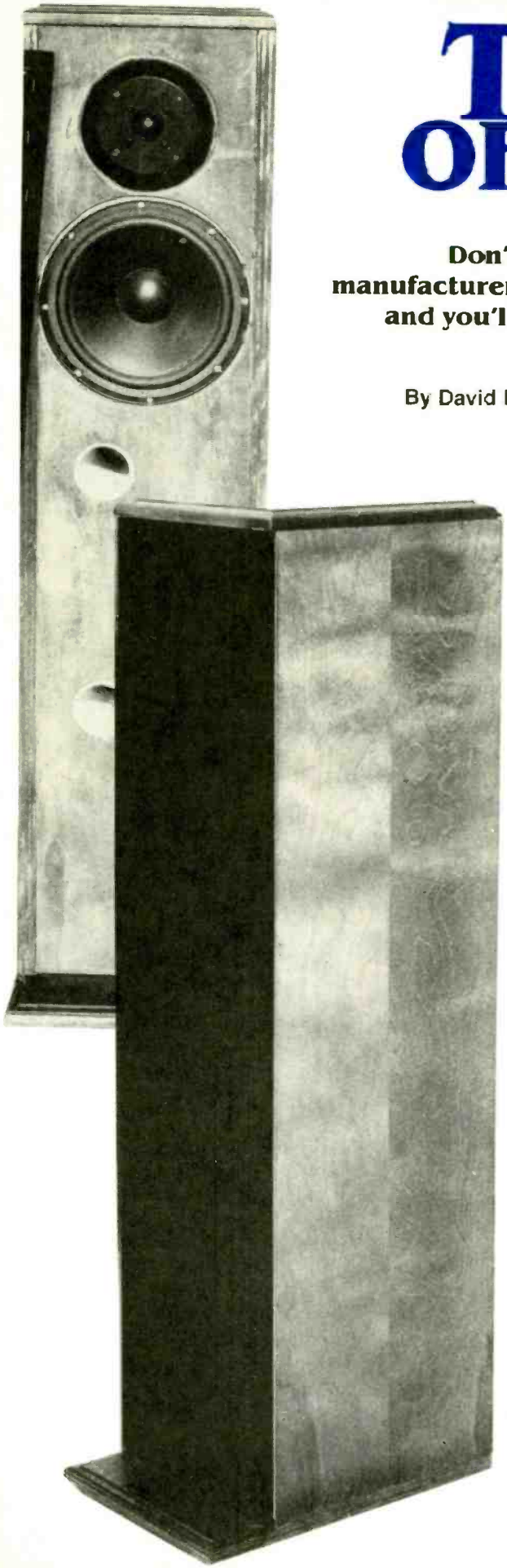
Trim the coil leads as appropriate, then scrape or sand the enamel off the ends of the wire from the coil and connect the end of the coil nearest the capacitor to the Fahnstock clip, and the wire from the far end to the stator (stationary) plate contact. You can solder the wire as shown or use an alligator clip. If the variable capacitor has more than one set of plates use the largest section only. Don't use the screws sometimes found on the sides of variable capacitors for attaching wires.

The Antenna

Although I've had very good results using just 30 feet of wire indoors, for best results an outdoor antenna that is long, high, and in the clear, is hard to beat. You can use regular insulators to keep it away from metal objects, but rubber bands will also work. The wire for the antenna can be any diameter. You can make an almost-invisible antenna by using very-fine gauge wire. The antenna should be attached to the coupler at the Fahnstock clip. Later you might want to experiment with directional antennas, such as the loop or beverage.

You can have a lot of fun just tuning around the dial. You'll be surprised how far you can hear even low-power stations during the day with a good antenna, and at night signals from all over the nation can be heard.

Listening to far-away stations on the AM-broadcast band was my first introduction to the wonder of radio and electronics and I still get a kick out of it. ■



TOWERS OF POWER

Don't be at the mercy of a speaker manufacturer's specs. Build your own loudspeakers and you'll know exactly what you're getting.

By David B. Weems

If you have visited any audio showrooms recently, you have surely seen plenty of tower speakers. There are good reasons for their popularity. First, a tower puts the tweeter closer to "normal" ear height, eliminating the need for a stand. Also, towers are narrow, giving good horizontal sound distribution and better stereo imaging than wider enclosures. And they occupy very little floor space.

Even with their advantages, getting good sound from a tower can be tricky. There is the danger of nasty resonances when the longest dimension of a speaker enclosure is equal to or greater than three times the shortest dimension. Such enclosures can act like pipes, which are notoriously resonant.

Pipe resonance can be reduced by placing stuffing in the enclosure, but it can also be stiffled by breaking the pipe into sections. For that, the double-chamber reflex speaker is a natural.

Double-Chamber Reflex Design

Double-chamber reflex designs have been around for years, but are often overlooked. The compartments of a double-chamber box are tuned to two frequencies, one an octave above the other. Double tuning keeps the woofer(s) under control and reduces distortion. At the frequency of the lower resonance, the two chambers act as one and the driver sees their combined volumes as the real size of the box.

Double-chamber reflex enclosures were originally designed for use with any good eight-inch speaker with a specified volume of about 2.7 cubic feet, generous enough to avoid the problems that occur when a box is too small. That is one of the advantages of the double-chamber design—it works well even without a careful match between the enclosure and the driver. Now, modern design techniques allow us to tailor the enclosure to suit any specific driver. However, the techniques involved are beyond ths scope of this article. Instead, we will concentrate on a design that the author has found successful. It is one that can be readily reproduced, and uses easy-to-obtain parts.

The speaker described here consists of an eight-inch woofer and a one-inch tweeter in a double-chamber reflex tower that's 10-inches wide × 40-inches tall × 12¼-inches deep. The woofer is the Precision TX 205-F, made in the U.S.A.; the tweeter, a soft dome Audax HD 100 D 25. Both the speakers and the crossover components, are available from McGee Radio (see the Parts List). The total cubic volume of the two reflex chambers is about 36 liters or 1.27 cubic feet. The tuned frequencies are 40 and 80 Hz.

Special Precautions

It is desirable to use any reflex speaker with an amplifier or receiver with a good infrasonic (subsonic) filter. If such a filter is not available on your audio equipment, you can still use tower speakers. Just use

care in feeding a signal that contains pulses into your speakers at high power. Such pulses can be produced by some turntables, FM tuners, and other sources. You can check your equipment for subsonic garbage by removing the grille from your speakers and watching the woofer cones. If the cones show excessive movement (also called throw) with any audio source, use that source with care.

When you select materials for a part of the enclosures, put solidity above appearance. If you use plywood—a logical choice for the external panels—make sure it has no voids or loose layers. Good-quality hardwood plywood is usually adequate. Particle board (the suggested material for part of the enclosure) is more solid, but even it varies in density. The sections, the quantity required, the materials used, and their dimensions, are listed in Table 1.

Take Note

Be aware that the drawings in this article show the dimensions of the chambers before any special treatment of the panels, as described later. The final dimensions of the larger chamber are about 7½- × 9¾- × 20-inches. The second chamber has the same width and depth, but the height is about half that of the larger one.

One difference between the photographs and drawings can be seen in the edges of the top and bottom pieces. Those parts in the towers shown in the photographs were run through a shaper to add an interesting curve to the edges. If a shaper isn't available, a simple square edge will suffice. You can cover the raw edges of the plywood with thin strips of wood veneer, which is available at building-supply stores. Or you can alter the dimensions of the top and bottom pieces and add a solid wood trim of your own choice.

Speaker-Board Construction

Start out by making the woofer and tweeter cut-outs on the speaker board using the dimensions given in Fig. 1A. The speaker board requires careful handling because of the small amount of material left at each side of the woofer hole. Set the woofer in the cut-out and rotate it until two opposite mounting holes in the woofer frame are in a horizontal position over the narrow sections of the board. Those two holes will not be used. Mark the locations of the *other* bolt holes and remove

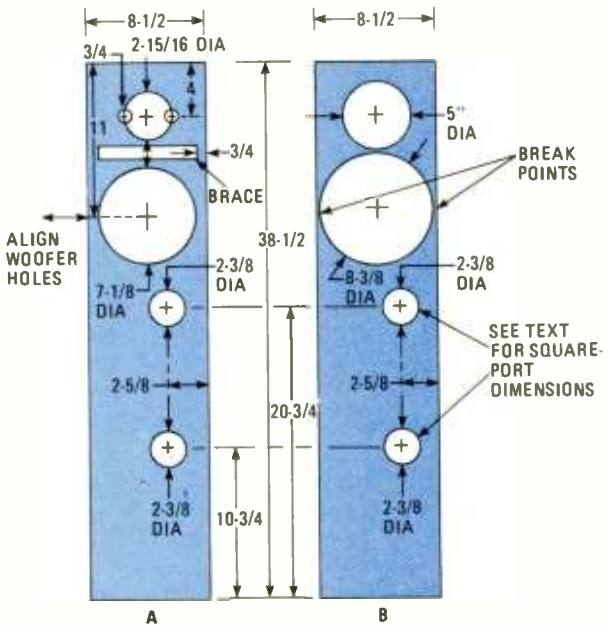


Fig. 1—All dimensions for the speaker board (A) and the faceplate (B) are given in inches. Allow your saw to cut through the remaining thin pieces of board on the faceplate while cutting the hole for the woofer.

the speaker. Drill a ¼-in. hole in each marked location. Place the speaker board face down on a large flat surface to support it. Drive a 3/16-inch T-nut into the back of the board into each of the drilled holes.

Don't be concerned about the strength of the speaker panel. It will be strong enough when it is glued into the enclosure with the cleats behind bonded to it. However, while working on other sections it may be advisable to clamp a board over the woofer hole. Do not cut the port holes yet.

Attaching The Faceplate

Now you can cut the speaker holes in the ¼-inch plywood faceplate section. When cutting the woofer hole allow the saw to cut the face plate in two at the two indicated breakpoints (see Fig. 1B). After making the cut-out for the tweeter, round off the edges of the faceplate at the tweeter hole. Glue the two faceplate pieces to the speaker board before cutting the holes for the ports.

Finally, you will need to cut the port holes as shown. The left tower should have port holes to the right of center and the right tower should have its ports to the left of center, so remember to flip the pattern when cutting the port holes for the right tower.

If you have no way to mark and cut a perfect circle of the precise diameter needed (2⅜-inches for most 2-inch I.D. pipe), you can stencil around the pipe or even change to a port with a square cross-section. In the last case, make the internal dimensions of the port 1¾- × 1¾- × 5½-inches.

After cutting the holes for the ports, attach a ¾- × ¾-inch brace across the back of the speaker board in the space between the woofer and the tweeter holes.

TABLE 1—SECTION INFORMATION

Section	Quantity	Material	Thickness (Inches)	Dimensions (Inches)
Top	2	Hardwood Plywood	¾	12¼ × 10
Partition	4	" "	"	10 × 8½
Bottom	2	" "	"	15½ × 10
Side Panels	4	" "	"	12 × 38½
Speaker Board	2	Particle Board or Plywood	"	8½ × 38½
Back Panel	2	"	"	8½ × 32½
Faceplate	2	Plywood	¼	8½ × 38½
Cleat ①	4	Pine	¾ × ¾	10
Cleat ②	8	"	"	19¾
Cleat ③	8	"	"	8½
Cleat ④	4	"	"	5½
Cleat ⑤ & ⑨ & Brace	14	"	"	7
Cleat ⑥	4	"	"	6¼
Cleat ⑦	2	"	"	8½
Cleat ⑧	8	"	"	10¼
Lattice Ⓐ	8	Lattice Work	1⅛	7 11/16
Lattice Ⓑ	4	"	"	38 7/16
Lattice Ⓒ	4	"	"	Cut to Fit
Port	6	PVC Tube	2 Dia.	5½

Assembly with Cleats

Of course you will need to cut the large sections shown in Fig. 2 before proceeding further. Refer back to Table 1 to determine the proper material for each section. Please note that only two of the four partitions (as shown in Fig. 2B) should have holes.

You will also need to cut the cleats using Table 1 as a guide. Pre-drill the vertical cleats (the even-numbered ones) for wood screws that will be used for the complete sectional assembly. They will require no less than four holes each. Then attach those cleats to the sides with glue and 1¼-inch nails (see Fig. 3), placing the pre-drilled holes in position for later use. Pre-drill and install the remaining cleats on the top, the partitions, and the bottom. Wait until the glue sets well before proceeding with the assembly of the tower.

Sectional Assembly

When the glue has set, glue and screw the bottom, partitions, and top to the sides using wood screws put through the pre-drilled holes. Use care when matching panels so that they fit well enough to make strong, air-tight joints. Also, caulk all joints with a good grade of caulking material, preferably silicone rubber. Caulk only on the inside of the cabinet for best appearance. The caulking is required because it is absolutely essential to have no air leaks or the reflex system will not perform according to plan.

Next, install the speaker panel with glue and nails. Again, when the glue is set, caulk the joints around the edge of the panel. Prepare the back by drilling it for air-tight speaker terminals.

The L-Pad

You can install the L-pad in the upper back, if you wish, but that complicates the wiring a bit. It is much simpler to put the L-pad on a small board as part of the crossover network at the bottom of the tower. Once it is set, it is unlikely you will ever change the tweeter level unless you move the speakers to a different listening environment.

Since you will put all the crossover components in the base, you'll need to run wire, such as lamp cord, up the back to separate terminals for the woofer and tweeter. Drill holes for the terminal lugs and solder about 18-inches of inner-box cable to the lugs before you glue down the terminal strip on the back. Caulk the holes on the inside of the back with silicone rubber. If you prefer, you can simply run the speaker cables through small holes in the back and caulk the holes.

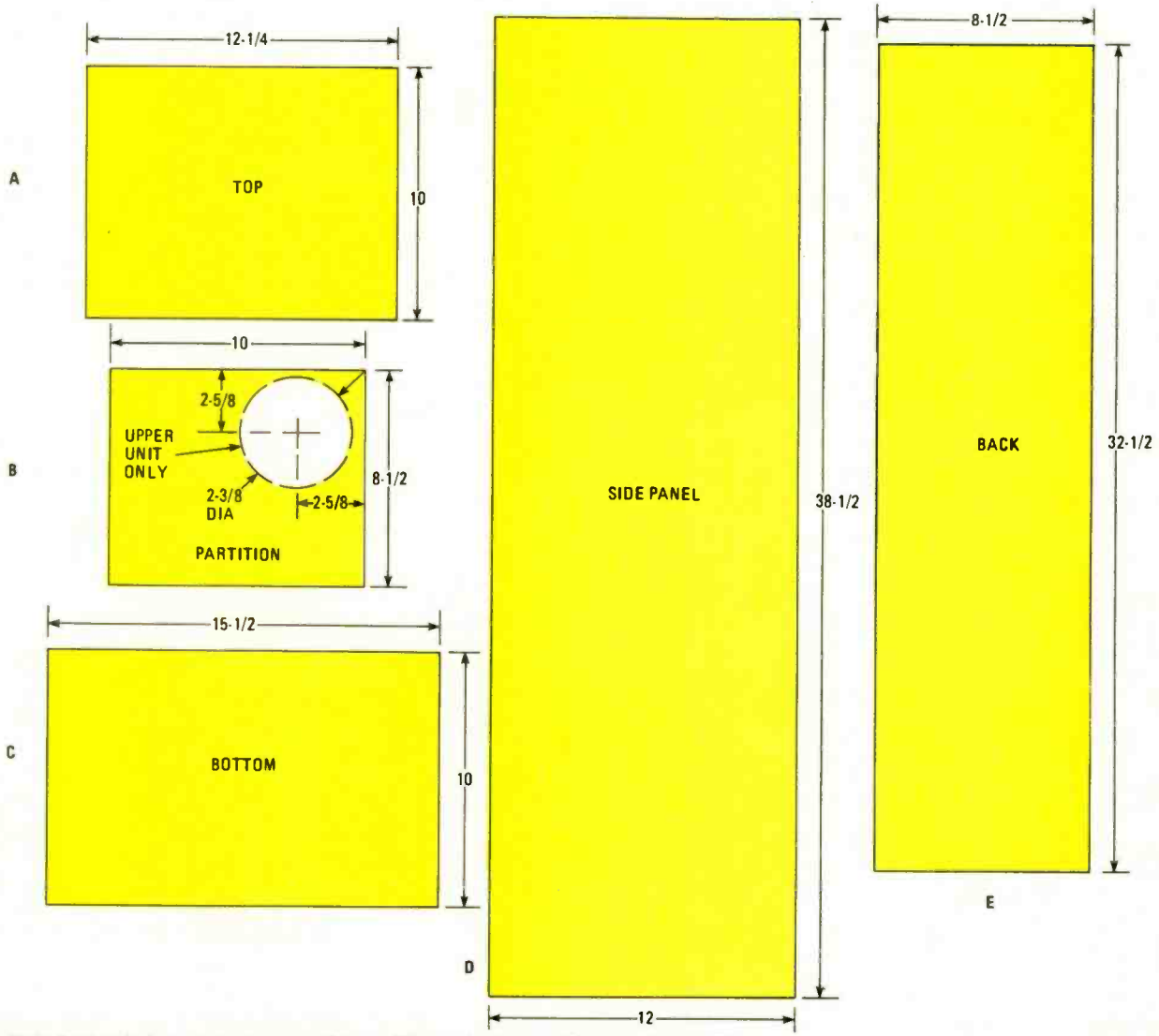


Fig. 2—Note that only two of the four partitions (B) require holes. The partitions with the holes must be placed inside the cabinet so that the holes will be on the same side as the front ports. See Table 1 for the materials list.

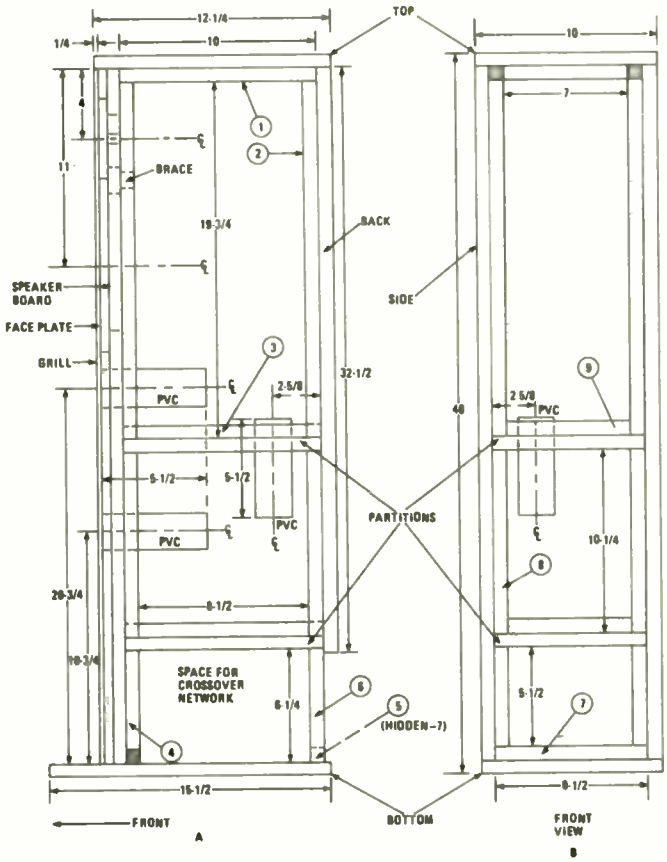


Fig. 3—All dimensions for the cabinet are given in inches. The side view (A) is what you would see with one of the sides removed. The front view (B) is what you would see with the front taken off. One brace of each type is numbered and the numbers correspond to those in Table 1. Brace 5 is hidden from both views, but is pointed to.

Special Treatment

It's important to add some stiffening and damping material to the walls. Asphalt roofing material makes an excellent cabinet liner. You can find scraps of roofing at many building sites (you only need a few shingles).

The adhesive called "Liquid Nails" works well as a glue for the shingles. Builders usually recommend an asphalt-base adhesive for shingles, but they are concerned with performance on the roofs of buildings where weathering occurs. The asphalt adhesives seem to take weeks to set so Liquid Nails is strongly recommended.

Apply a coating of the adhesive on the enclosure wall, then quickly staple a piece of shingle over it. Do that for all the inner surfaces of the larger chamber except the speaker board. In the smaller chamber it should be added to the sides, back, and bottom partition.

Acoustical Touches

When the adhesive has set, apply another thin coat of Liquid Nails and staple sections of thin indoor/outdoor carpet over the roofing material, with the foam side facing the wood. The ideal carpet for this job is about ¼-inch thick. Half of the thickness consists of a polyurethane foam backing. The combination of carpet and roofing does a good job of deadening the enclosure walls.

Staple pieces of acoustical Fibreglas, 1-inch thick, to each inner surface of the large chamber except the speaker panel. Place a small piece on the upper surface of the bottom partition in the second chamber. If you have any left, add it to the layer of Fibreglas on the inside of the back panel in the large chamber, directly behind the woofer.

The Back and Grille

Install the back panel. If you want to conduct any experiments with damping material, run a strip of foam weather stripping around the edges and across each partition; then install the panel with screws. For the final installation, use a liberal bead of silicone rubber sealer on the rear cleats and nail down the back. The silicone rubber makes a perfect seal for any joint that you can't reach to caulk later. After gluing down the back you can still gain access to the interior of the larger chamber by removing the woofer.

Cut the 1⅛-inch lattice material to the lengths described in Table 1. Make the grille frame from it by stapling it together with heavy-duty staples using Fig. 4 as a guide. Spray the frame's front surface flat black and drape the grille cloth around the frame. Wrap the cloth around the lattice work and attach it with staples to back side of the grille.

Put the grille in place, and if any part of the speaker panel shows through the grille cloth, darken it with stain or black paint. Finish all the external wood surfaces before installing your speakers or crossover network.

Crossover Network

If you apply the usual formulas to the values shown in the schematic diagram of the crossover network in Fig. 5, you will notice some variation from common practice. The values

PARTS LIST FOR ONE TOWER SPEAKER

CAPACITORS
(All capacitors are nonpolarized and rated at 100-WVDC; see text)
C1, C3—4.7μF
C2—12μF
C4—50μF
C5—24μF

RESISTORS
R1—5.2-ohm, 25-watt
R2—8-ohm, 25-watt
R3—8-ohm, L-pad

INDUCTORS
L1—0.26-mH, coil
L2—1-mH, coil
L3—0.51-mH, coil

ADDITIONAL PARTS AND MATERIALS
SPKR1—Audax HD-100 D-25
SPKR2—Precision TX-205 F-8
Terminal blocks; wood supplies and 2-in. I.D., PVC tubing (see Table 1 for materials and quantities); polyester-knit grille cloth 12-in. × 40-in.; wood glue; Liquid Nails; silicone-rubber sealer; foam-backed carpeting; lamp cord, #18 or heavier; 3 doz. #8 × 1¼-in. wood screws, for glue blocks; 6⅜₁₆-in. T-nuts; 6⅜₁₆-in. round-head bolts; nails 1¼-in. long; ½-yd.², of 1-in. thick acoustical Fiberglas; asphalt roofing pieces.

Speakers and crossover components are available from McGee Radio Co., 1901 McGee St., Kansas City, MO 64108. Radio Shack sells a package containing 1 yd.², 1-in. thick acoustical Fiberglas (enough for both enclosures).

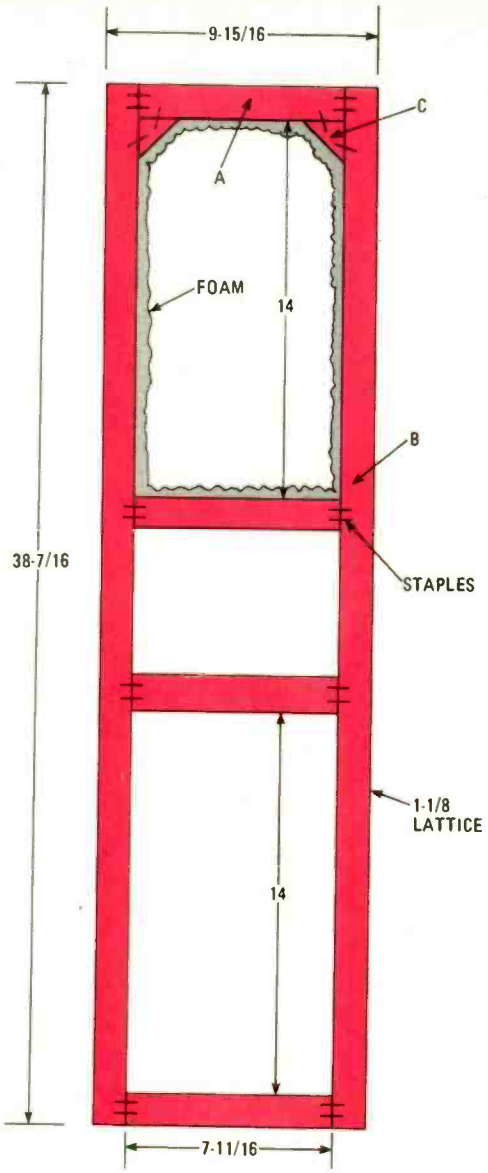


Fig. 4—The dimensions in this drawing of the speaker grille are all given in inches. The lattice-work pieces are lettered to correspond to those in Table 1.

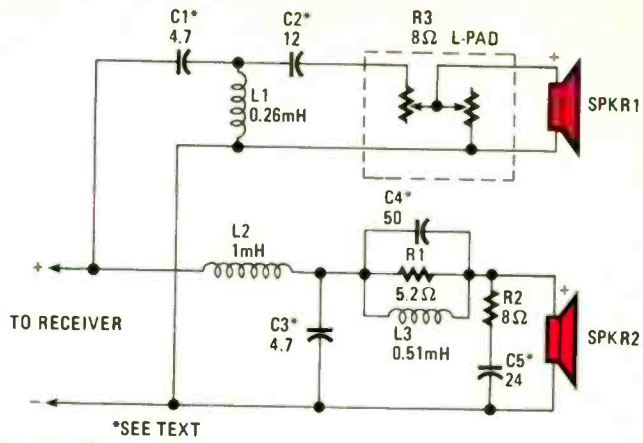


Fig. 5—The crossover circuitry is simple to build and its schematic diagram is shown here. The dashed box around the L-pad indicates that its wiring is internal to that unit.

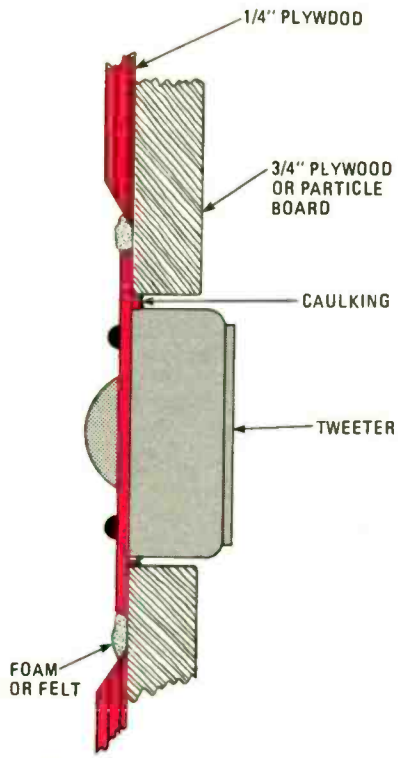


Fig. 6—If done with care, the tweeter can be seated in the faceplate without fasteners. The caulk should hold it in place. Attach the foam after the caulk has dried.

shown in the diagram were selected after testing the system, rather than by formula alone.

The Parts List specifies ordinary non-polarized electrolytic capacitors, which work well. Some speaker-design engineers insist on Mylar or polypropylene speaker capacitors, particularly in the tweeter circuit. If you decide to substitute the more expensive Mylar or polypropylene units, you should change the values of C1 and C2 because the typical non-polarized capacitor runs lower than its polarized counterpart. To make the change, reduce the value of C1 to 4μF and the value of C2 to 10μF.

In setting up the crossover network, don't install the various coils too close to each other. If you must place one within a couple of inches of another coil, set the two at right angles to each other. And keep them away from pieces of iron or steel.

You can use a small wooden board as a chassis for the network. Mount each component securely by using an adhesive, such as mounting tape or epoxy, to hold it in place. Point-to-point soldering is a suitable connection method. The board should be securely mounted to the cabinet floor to prevent rattling.

Once in place, connect the driver wires to the appropriate points in the circuit. Speaker polarity is important, so be sure you know the polarity of the driver leads.

Tweeter Mounting

Set each tower on its back to install the drivers. Draw the tweeter cable out through the tweeter cut-out and solder the leads to the tweeter lugs (be sure to observe the correct polarity).

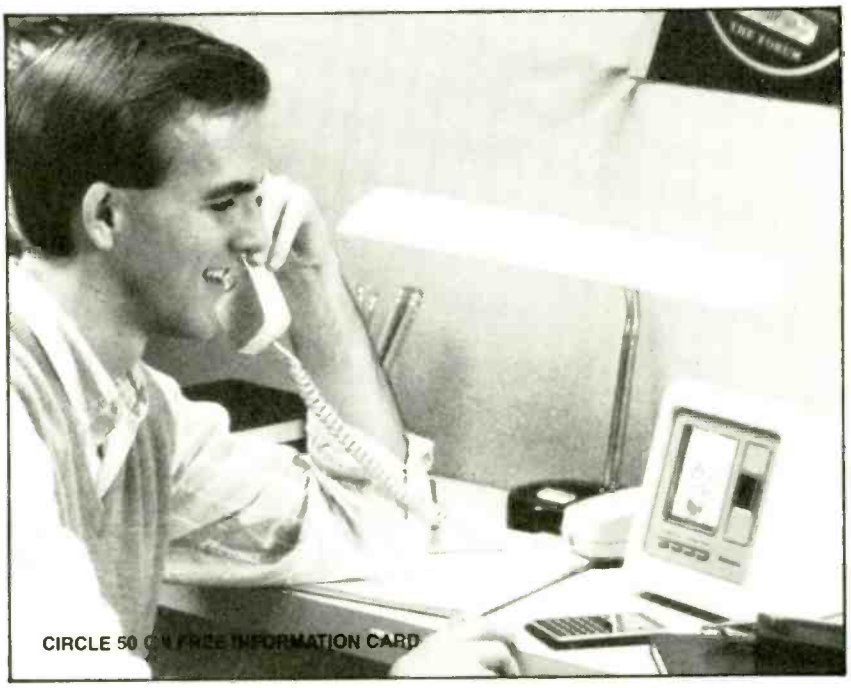
Run a thin bead of silicone rubber sealer around the edge of the cut-out and press the tweeter into it (see Fig. 6). Twist the tweeter gently to make sure the sealer is evenly dispersed under it. Mounting screws are unnecessary. Glue a ring of

(Continued on page 106)

GIZMO

OCTOBER 1988 GIZMOLOGY TODAY VOLUME 1, NUMBER 8

Visitel Visual Telephone Display. pg. 1
Walkman Stereo Cassette Recorder/ Player . . . . . pg. 2
Video Cut 10 . . . . . pg. 3
Swisstel Telephone . . . . . pg. 4
Sony 8-mm Video Camcorder . . pg. 6
Dial-It Cordless Tone Generator . . . . . pg. 7
Fisher Hi-Fi To Go . . . . . pg. 7
Automatic Peeler . . . . . pg. 8
Electronic Auto Compass . . . . . pg. 8
Nikko Gamma Tuner . . . . . pg. 8
Packtronics Video Light Meter . . pg. 8
Plus U.S.A. Uovo Nuovo. . . . . pg. 8
Case Logic 120 Cassette Case . pg. 9
Citizen Portable Fax Machine . . pg. 9
Desk Top Office Revenger . . . . . pg. 9
Fascinations Movie Viewer . . . . . pg. 9
Swimtech Lap Counter . . . . . pg. 9
Citizen Hand-Held LCD-TV . . . . pg. 10
Code-A-Phone Tapeless Answering Device . . . . . pg. 10
Onkyo Universal Remote . . . . . pg. 10
Panasonic Scientific Calculator pg. 10
Ricoh Personal Portable Copier . . pg. 10
Aiwa AM/FM Stereo Recorder . pg. 11
Braun Food Processor . . . . . pg. 11
Panasonic Clock Radio . . . . . pg. 11
Sharp Microwave Oven . . . . . pg. 11
Telephone Message Stopper . . pg. 11
Bose Roommate II Powered Loudspeaker . . . . . pg. 12
Hitachi Four-Head VCR. . . . . pg. 12
Serpico Recreational Vehicle Alarm . . . . . pg. 12
Sharp High-Speed Facsimile . . pg. 12
Workstation Anti-Glare Filters. . pg. 12



Show and Tell

VISITEL VISUAL TELEPHONE DISPLAY (LU-500). Manufactured by: Mitsubishi Visual Telecom Division, 3350 Scott Blvd., Building 49, Santa Clara, CA 95054. Price: $399.

The future's finally here, it just took longer than expected to arrive. And, unfortunately, up close it's not quite the marvel that was once promised.

Of course, the future we're referring to is the "picturephone," first unveiled by AT&T at the New York World's Fair some 24 years ago.

The 1964 picturephone was reputedly capable of transmitting and receiving moving images. The *Mitsubishi Visual Telecom* product, the *Visitel Visual Telephone Display*, is limited to stills—snapshots really—and during transmission (five or six seconds per 2¾- by 3¼-inch image) callers can't talk. In fact, if one party is talking when the send button is pushed, the audio overrides the video.

The Visitel connects to a telephone like an answering machine or other accessory. The phone is connected to the Visitel, with a line from the visual-display unit going to the phone outlet. The visual-telephone display is also plugged into an electrical outlet with a supplied AC adapter.

Operation is as simple as installation. A sliding door over the instrument's video-camera lens turns the unit on or off. Opened half way, the sliding cover allows the unit to receive images, but not to send them. Under the Visitel screen, two controls adjust brightness. A "view/pose" control accesses a three-image memory, brings up a graphic on the screen, or shows the live image of the user. Transmission is activated with a touch of the "send" key.

Once warmed up (about 20 seconds), the Visitel is ready to display and send images on a video screen offering resolution described as "96 by 96 pixels and 32 levels of gray scale." Of course, if you plan to trade video snapshots, it would help if the party at the other end is also equipped with a Visitel.

The image sent and received has more in common with a facsimile transmission than, say, a television broadcast. Quality is comparable to the output of a surveillance camera. As might be imagined with a screen boasting 32 levels of gray scale, the

picture is monochromatic in the extreme. Even a fairly wide brightness range doesn't completely remove a sort of black-and-white solarization effect that is characteristic of Visitel images.

Lighting has its effect, and we found that moving the device around to take advantage of the best lighting conditions could improve the final image. In the instructions, it's suggested that the Visitel should be lit from above and behind for best results. There's also a warning against "pointing the camera at any bright light." Such exposure could "burn an image into the camera." The lens-to-caller distance that offers the clearest image is about 20 inches.

Low resolution is also a limitation. GIZMO first used the device with the California public-relations agency that represents Visitel. Although the main headline in that day's *Los Angeles Times* was legible, it was impossible to read the dateline under the newspaper's logo. In general, only the paper's largest type sizes were readable on the screen.

The memory facility adds some variation. As GIZMO's testers discovered, simple three-picture narratives could be put together and transmitted in both directions. Using the SEND/POSE control to bring a stored image up on the screen allows the receiving unit to send those images back to the originating Visitel. The memory is canceled once the Visitel is turned off.

In terms of amusement, the Visitel's low resolution makes visual trickery possible. If the correct photos (in terms of size and clarity) were used, a caller could claim to look like Paul Newman or Elizabeth Taylor, offering a carefully held picture of the star as "proof." Similarly, a photograph of a spectacular room clipped from a design magazine could be used as a backdrop. Various combinations of still and "live" action might also be used in pursuit of all manner of visual illusion.

An unlikely consumer device, we imagined unlikely buyers for it (apart from the legions of gizmo fanatics and fans). Parents who are concerned their kids aren't spending enough time on the telephone might want to get a pair of the units. Reclusive eccentrics (like the late Howard Hughes) might appreciate a limited visual dimension to add to their limited audio connection with the world. Visitel certainly won't inadvertently reveal any secrets via its camera.

In fact, caller's control over whether to send an image or not overcomes one of the obstacles that dogged the original "picturephone." Many commentators worried about what that new device might do to the concept of privacy.

Practicality aside, the Visitel is a fun toy to play with. In terms of sophisticated telecommunications, however, we came away thinking of a childhood toy called a "Viewmaster." That device, which incidently is still being manufactured, is an update of the 19th-century stereopticon. In some ways, the stereopticon and the Viewmaster viewer were the primitive forerunners of the contemporary explosion in image-related entertainment equipment. Perhaps in the same way, in future years the "picturephone" and the Visitel will be seen as a first step leading to a new era of private audio-visual communication.

Changes are in store for the Visitel. At the summer CES the company indicated that the new model (LU-501) is equipped with video outputs, allowing Visitel-transmitted images to be stored on videotape. One modification we would suggest is a remote control, wired or otherwise, for the send function. Between holding the telephone receiver and sitting at the optimum focusing distance, a user often ends up sending a shot of his or her arm reaching for the transmission button.

One odd aspect of using the Visitel is watching yourself on the screen between transmissions of still pictures. It's a face-to-face situation alright, but then so is sitting in front of a mirror while making a call.

Both Panasonic and Sony have developed similar devices that, thankfully, can communicate with each other. The Visitel and competing products, along with the recent tremendous increase in facsimile transmission, suggest that something like the era promised by the 1964 World's Fair "picturephone" could be on the horizon. ■

Audio Extremities

WALKMAN STEREO CASSETTE RECORDER/PLAYER (WM-D3). Manufactured by: Sony Corp. of America, Sony Dr., Park Ridge, NJ 07656. Price: $379.95. Portable Cassette-Corder (TM-11). Manufactured by: Sony Corp. of America. Price: $39.95.

CIRCLE 51 ON FREE INFORMATION CARD

The pocket tape recorder/player is a benchmark product of the contemporary electronics era. It's undergone significant advances in the little-more than a decade since the product was introduced. The solidity and reliability of the old mono handhelds have been displaced in the *Walkman* era by sophisticated electronic capabilities in an extraordinarily compact form.

A consumer can fit a portable recording studio of more than respectable capability into a jacket pocket. But there seems to be a law of diminishing returns at work. Those magic machines pack a million-dollar sound system into a dime-store case. The combination of delicate innards and flimsy protection, have evolved into a hand-held recorder that's liable to break, often mysteriously, at the slightest provocation.

Sony's WM-D3 stereo Cassette-Corder, dubbed the "Walkman Professional," and *TM-11* mono Cassette-Corder represent the high and low end of a product field practically invented around the brand name *Walkman*. (Or did; subsequent to our purchase of the budget-priced TM-11, it was replaced by the *TCM-21*, the "Pressman" Cassette-Corder, which also is a mono unit.)

A leading New York electronics store described the WM-D3 as the best handheld tape recorder on the market. The TM-11 was purchased in New Orleans.

The budget-priced TM-11 was a maddeningly unsatisfactory piece of equipment from the moment it left the store. Its mono-recording capabilities are far inferior to similarly priced models from

years ago, and it also revealed itself as a horrible medium for playback. What's more, its construction is monumentally flimsy. Among sounds the TM-11 proved incapable of clearly recording or playing back were conversations, live music, and even incidental crowd noises.

As if in anticipation of our next impulse, the TM-11 came to a quick end within weeks of its purchase. A drop off the end of a table put an end to its short, miserable life. Sony is to be commended for replacing it with a hopefully improved model. Consider this the TM-11's obituary.

Though we have not had a chance to personally review the current TCM-21 Pressman, "Sony's most affordable hand-held Cassette-Corder" features single-touch recording, cue and audio review during fast forward and rewind, auto shut-off, built-in microphone and something called "instant edit." If our experience with the TM-11 was representative, the TCM-21 should feature a better microphone.

Our faith in state-of-the-art was renewed by the tremendous performance of the Sony top-of-the-line entry, the WM-D3. We still recall how miraculous the audio quality of the first Walkman we ever listened to seemed at the time. The WM-D3's performance inspired the same kind of disbelieving astonishment. In a variety of crowded, noisy nightclubs and open-air concert settings, that Walkman stereo unit recorded live music, from delicate acoustic instruments to high-decibel rock-and-roll, with astonishing fidelity.

After using the WM-D3, it's not difficult to understand how Texas folk singer Michelle Shocked was able to record a best-selling album of her music using a portable Walkman (model unspecified). (In an irony only possible in the current techno-overkill atmosphere of the record industry, Shocked's campfire performance from the Texas countryside, recorded with a hand-held recorder, is now commercially available in this country on compact disc.)

Pressman Cassette-Corder

The diminutive WM-D3's versatility is also impressive, with excellent playback capability and a plug-in condenser microphone of exceptional quality and small size. We used the microphone both clipped to our clothing and resting on a supplied stand; results in both situations were most satisfactory.

The unit's impressive dynamic range, according to Sony, is the result of a "laser amorphous tape head." The WM-D3 can also be connected to most component systems for either record or playback purposes, which adds further to its versatility.

As impressive as its performance is, the unit is not without drawbacks. The recorder/player's design, intended to pack the most audio electronics into the smallest space possible, dictates that the cassette is loaded into a door covering the back of the machine, a configuration that almost invites breakage. Not so much flimsy as delicate, the "cassette holder" door is a design feature long overdue for retirement.

The case, too, deserves to be described as cheesy, raising the question of whether it will provide even a modicum of safety for the fragile electronics inside.

The suspicion grows that manufacturers aren't nearly as interested in case durability as consumers are. If only by virtue of their portability and size, most miniature recorder/players probably come to an "unnatural" end, as represented by sudden falls of sharp impact. Even supplying a carrying case isn't an answer. Consumers have a tendency to discard or lose the often unattractive fabric containers, and trying to operate a recorder when it's fully dressed can be clumsy and cumbersome.

A budget-priced unit not worth having at any price, and a high-performance model barely encased in plastic suggest a marketing cynicism that takes the pleasure out of consumer-audio use. Miracles of the audio variety come in small packages. We just wish they came in sturdier ones. ■

Vid Bid

VIDEO CUT 10. Distributed by: Photo Systems, Inc., 7200 Huron River Dr., Dexter, MI 48130. Price: $1,249.95.

Like eight-track audio tape, 8-mm (and super-8) motion pictures appear to be a technology who's time has come and gone, at least on the consumer front. Done in by video, the fall of 8-mm celluloid left a number of manufacturers and suppliers in a potential limbo.

One of those firms, *Hama* of West Germany, an important supplier of 8-mm accessories, has continued in 8-mm, but changed mediums from film to videotape. Among the first results of that repositioning (although the firm remains deeply involved in the photographic industry) is the *Video Cut 10*. That unit is an editing deck that promises to put sophisticated technology within reach of home-video enthusiasts (or at least those that are well-heeled), the same consumers who have

CIRCLE 52 ON FREE INFORMATION CARD

made the big-ticket camcorder (including 8-mm format units) the fastest-selling product in all of *videodom*.

Anyone who has sat through a sleep-inducing, unedited videotape of a wedding ceremony or vacation trip, will understand the potential of an editing deck. Especially if the drowsy cassette was one of your own.

The Video Cut 10 connects an 8-mm camcorder or player to any VCR, including VHS format. Equipped with a fold-up LCD screen, the unit's circuitry and computer technology allows the user to mark selected segments of a recorded cassette (up to 50 different segments or "cuts"), which can then be rearranged sequentially, deleted, duplicated, and modified. Slow-motion and still-picture treatments are possible if the 8-mm player used is equipped with those capabilities.

Once the edited program is organized in the Cut 10 memory, the user can preview the entire sequence before actually committing it to cassette. An editing-deck control labeled PERFORM transfers the created sequence of segments from the 8-mm tape in the camcorder onto the cassette in the video recorder. The Cut 10 memory stores only the cut "in" cut "out" (that is, beginning and end of scene) data, organizing it via pulses read from the tape counter of the 8-mm camcorder. A counter on the editing deck displays the same numbers as the camcorder meter. The problem of precisely counting frames, according to a Hama representative who demonstrated the deck, represented a primary technological challenge in designing the unit.

Camcorders in the 8-mm format use a frame-count system that fulfills the Cut 10's requirements. Designing a companion model for use with VHS necessitated a more elaborate (and expensive) approach.

Even in the field of 8-mm video, standardization is far from universal. The unit, as it's presently offered, works with eight different 8-mm camcorder and player makes in 15 different models. With any of those, the deck requires a "system code." The user must set the Cut 10 for the camcorder or player to which it is connected. Pressing a "system code" button on the deck brings those words up on the display. The user then enters a number corresponding to the make and model of player/camcorder. The numeric code comes from a printed list included in the instructions.

Reflecting Cut 10's European manufacture, compatible video units include a number of brands unknown in the American market; Blauppunkt, Bosch/Bauer, Grundig, Bondstec, and ITT. More familiar compatible brands include Canon, GE, Panasonic, Sanyo, and, of course, Sony. What the "system code" adjusts the unit for is the passage of seconds between engagement of controls and activation of the tape. Once the player and recorder are attached via the Cut 10, all equipment is controlled by the editing deck.

The display keeps the user in touch with what function is being performed and the arrangement, deletion, and duplication of selected scenes. There's also a timer, and indicators showing which connected unit is active and other time and process-related data. So much so that Hama suggests the home editor keep a separate written list of cuts and the sequences being created with them. The instructions include suggested forms for manual record keeping, a surprisingly low-tech adaptation to the limits of the human memory. Hama hopes to incorporate that function, electronically, in future models of the Cut 10.

The LCD numbers are a bit overwhelming at first glance. There are time-related numbers (including a stop-watch function), frame digits, the numbers assigned to each of the cut segments, and a few more whose purpose we never did quite nail down.

The 49-button control panel shares a number of characteristics with a computer keyboard, including the all-important "cancel" function, allowing the home editor to delete mistakes before they happen. Similarly, a cursor on the display keeps track of the segment or cut being moved or modified, showing the operator its assigned position in a row of numbers that represent tape segments.

The unit takes a stab at reducing user confusion with "interactive operator guidance"—displays that indicate where a problem or glitch might be originating. Still, it seems to us that the Video Cut 10 might not be the first accessory a novice would want to add to a home-video arsenal. In demonstration, the Video Cut 10 was a compact marvel of precision and memory, a smaller sibling to the professional equipment used in the television industry, and related fields.

But even in a highly controlled run-through, the potential for operator confusion was clear. The rather verbose German-to-English translated instructions aren't likely to clarify much, at least in their draft version. If someone knows the German term for "troubleshooting section," they should suggest it to the manufacturer.

The companion Video Cut 20, which is capable of transferring from VHS cassette (as well as 8-mm video), has a suggested retail price of $2,200, which is substantially higher than its 8-mm counterpart. For the most part that reflects the necessity of developing a system for frame numbering that's compatible with the editing unit's needs and with home-video equipment. The solution was a straightforward adaptation of professional video's "vertical interval time code." For editing purposes, the Cut 20 generates its own frame numbers for VHS. But frame numbers can only be generated and assigned during recording, which means that it can't be used with existing VHS camcorders, according to Hama. Those machines, for reasons having to do with trade regulations, are outfitted with a chip that defeats the Video Cut 20's numbering functions in any but the "record" mode. Or so it was explained to GIZMO. The Cut 20 has twice the memory capacity as the 10; 100 scenes as opposed to 50. Also introduced with the Cuts 10 and 20 is a titlemaker, the Script 50 ($1,050). Its most user-friendly feature is its computer-style keyboard for letter, color, and effect generation. But the Script 50 is another report entirely. This trio of European video accessories promises a leap in the level of technology available in home video. For the present, the editing decks and the title generator would seem custom-made for business, commercial, and video operations like community and school cable or limited-range UHF TV station use. On the consumer front, if the Video Cut 10 can really edit the boredom out of home videos, its success (at just about any price) can't come a moment too soon. ■

Swiss Miss

SWISSTEL TELEPHONE. Manufactured by: Swisstel, Inc., 300-1(c) Route 17, Lodi, NJ 07644. Price: $89.95.

In the never-ending quest to advance the telephone from a simple tool of communication to an electronic-era human organ, new phones hit the market on a near-monthly basis. Mermaid telephones, cartoon character telephones, telephones with radios, and even telephones with televisions; from the perspective of either low comedy or high tech, hasn't the American telephone consumer just about seen it all?

Not according to *Swisstel*, described in publicity literature as a "subsidiary of Ascom, the Swiss telecommunications giant." Since the spring, the company has been introducing the *Swisstel Telephone* to Americans via extensive TV and magazine advertising. The thin, palm-size, one-piece instrument is labeled as nothing less than "an extension of you" (we weren't kidding about the telephone being promoted as a human organ).

Despite some innovative home-phone features, the Swisstel (in red, black, white, pink, blue, and transparent models) is being promoted primarily as a decorator accessory. Besides those six styles, it's also available in "black with rainbow dots," and patterned cases called "domino," "pink zap," and "stratos."

Built in Switzerland by people used to

working on small things, the Swisstel's slender half-inch thick silhouette is the result of robotically installed "state-of-the-art surface-mounted circuitry," according to the company. The instrument boasts 13 (the Swiss apparently aren't superstitious) features, including redial, access to call waiting and third-party calling, a PULSE/TONE switch, and RING-VOLUME control. Its fluttering bell-like ring sounds very European and is a welcome contrast to harsh electronic tones.

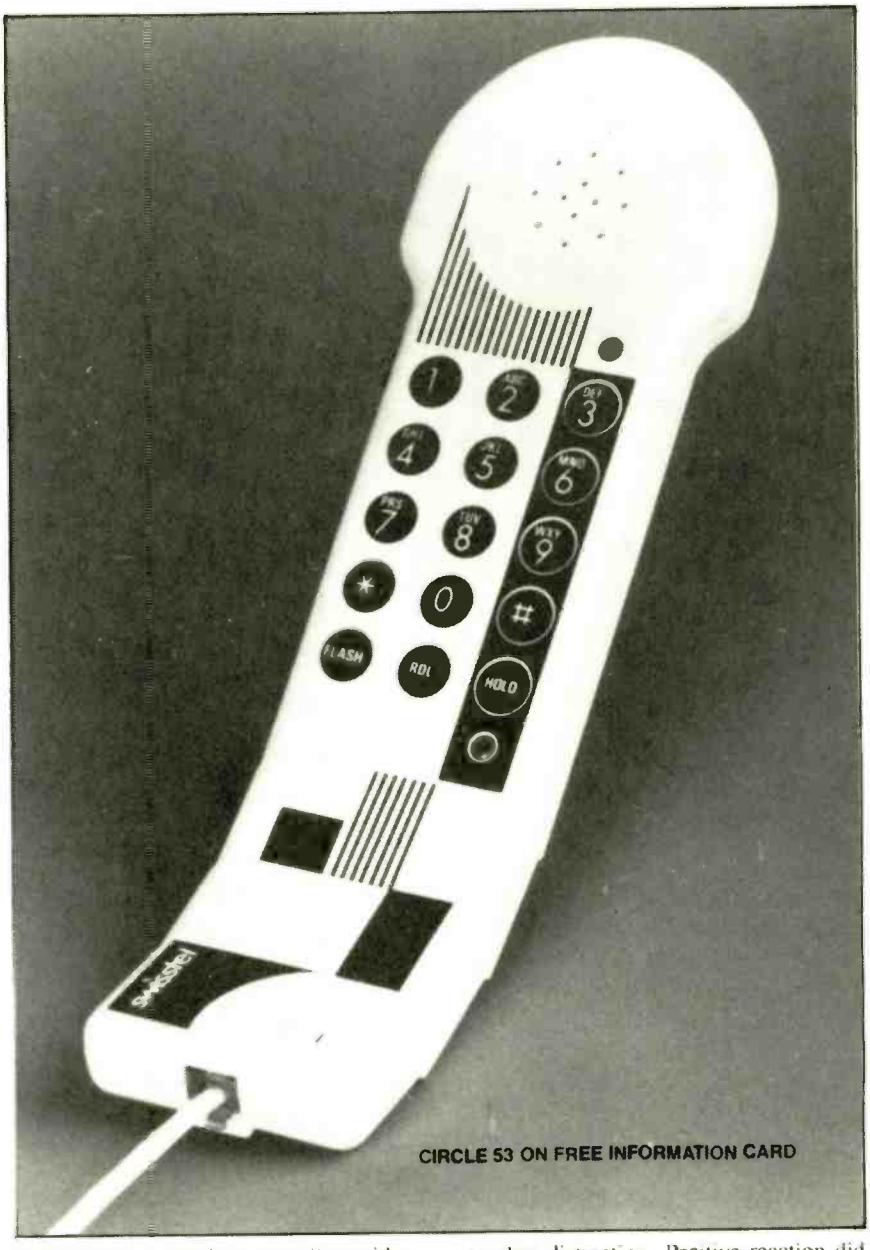
Unusual home-instrument features include a CALL-HOLDING button and a multi-function control labeled "flash." To remove a call from hold, the FLASH button is pressed. Depressing the HOLD button and then turning off the phone's power via a side-mounted switch, the user can go to another extension on the same line and the Swisstel automatically disconnects. If a Swisstel is used in conjunction with "call waiting," the user presses the FLASH button to receive the second call, pressing it a second time to return to the first conversation. The same control disconnects a call and brings up a dial tone without turning the Swisstel off and on again, in lieu of hanging up the phone.

An on/off signal light indicates when the telephone is on and the same light blinks when dialing in the pulse mode. A good feature because there's no audio indication of dialing, which for a first- or second-time user can be disorienting, to say the least.

The bottom third of the Swisstel torso is jointed, allowing the user (theoretically) to adjust the mouthpiece for maximum comfort and audio clarity. That is where our problems with this "extension of you" began. Frankly, neither ear nor mouth is well-served by the phone; sound quality is muffled at best. What's the use of a phone (no matter what its color or the elegance of its design) if you can't speak and hear clearly through it?

Maybe as a decorator accessory? The instrument's thin profile and six-inch length allows the Swisstel to hang unobtrusively on a well-decorated wall. As it must, because there's no stand or cradle to rest it on. Instead, a back-mounted retractable hook allows it to hang. We'd be careful about leaving the petite telephone on the floor, its small size and light weight make it especially susceptible to being stepped on or kicked around.

Instead of a cradle stand, Swisstel offers an accessories package (at $9.95), including a wall-mount phone hook; the "big hook," a removable, over-sized hook that attaches to the phone; "skid stoppers," which look suspiciously like color-coordinated rubber bands, but which promise to end dangerous skidding when you put the phone down; an earpiece cover ("provides a cushion for your ear"); and a much-needed shoulder cradle. The last item lets the user prop the phone between shoulder and ear; without it, long conversations could necessitate a visit to the local chiropractor.



CIRCLE 53 ON FREE INFORMATION CARD

Which brings us to another shortcoming that the compact chatterbox displayed during our test: The Swisstel, at least for an adult, is just not a comfortable telephone. Clever in design and execution, but not a phone to lean into for those long chats. Its light weight makes it feel too much like a toy, while its audio "quality" had us constantly fiddling with the earpiece and microphone during conversations. Background noise around the Swisstel isn't shielded in the least, and that becomes another distraction. Positive reaction did come from one user, a teen-ager who was intrigued by its thin lines and the way it hugs the side of the user's face. He was even more delighted when Swisstel's television ads began appearing, which we guess points up the phone's real strong point, marketing strategy as opposed to practical design.

It's a curious mix of the advanced and the inept, but that's apparently not supposed to matter to the 18-to-47-year-old affluent women identified in marketing information as the Swisstel's target consumers. But we have our doubts. Telephones should be nice to look at, but the invisible quality of audio performance would seem to be the real point, one we don't think the Swisstel Telephone makes. ■

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CIRCLE 54 ON FREE INFORMATION CARD

Eight is Enough

SONY 8-mm VIDEO CAMCORDER (CCD-V5). Manufactured by: Sony Corp. of America, Sony Drive, Park Ridge, NJ 07658. Price: $1,500.

After a little more than four years on the market, can it be said that the 8-mm video format has arrived? Well, yes and no. While it hasn't revolutionized video in quite the way that was predicted, it hasn't done the belly flop foreseen by some skeptical observers of the video market.

Instead the 8-mm format seems to have staked its claim to a chunk of the camcorder market. Its small size, as exemplified in *Sony's CCD-V5 Video Camera Recorder 8* "handycam," has been an important factor in the format's acceptance. The 8-mm videocam seems to be the camcorder of choice for many "home movie" fans for just that reason.

The CCD-V5 from Sony certainly seems representative of 8-mm's virtues. The compact 3-pound, 5-ounce (without battery) unit offers recording capability, playback, and an autofocus system that can make videotaping as easy as taking snapshots. The 8-mm video's cassette, with a 120 minute capacity, is just about the size of an audio tape. In a nice refinement, the cassettes also feature a sliding erase-protection tab.

Power for the unit comes from the usual trio of sources: standard household current (with the supplied AC pack/battery charger, ACP-88); a rechargeable battery (NP-22), good for one hour of continuous operation when fully charged; and an optional vehicle cigarette-lighter and DC pack (DCC-16AW, DCP-80, respectively) for drawing power from a 12-or 6-volt automotive battery. There's also a lithium battery (mounted in the unit's bottom) to activate the CCD-V5 clock and title-memory functions.

Ease of operation is a big part of the 8-mm video story, and the Sony lives up to the format's reputation for near point-and-shoot operation. The autofocus is impressive in its speed, while manual control and "macro" focus (for close-ups of small objects) increase the handycam's versatility. A six-power zoom can be adjusted manually or operated with a control just above the detachable grip on the right of the camera. Another well-designed control feature in the CCD-V5's POWER and CAMERA/PLAYER switch. A built-in safety catch makes it virtually impossible to set the unit to the wrong function.

In addition to allowing playback viewing, the electronic black-and-white viewfinder displays status and function information superimposed over the scene in view. Symbols and words offer lighting, white-balance, and mode indicators. Date and time can also be displayed and shown on the recorded tape. A note to consumers who might be concerned about correct date, according to the manual "the year indication will return to 1988 when it exceeds 2016." So you can figure on 28 years of correct-date information.

Describing the CCD-V5, naturally, isn't nearly as much fun as using it. A real pleasure, especially for the novice 8-mm-video user, is the clarity and resolution of the pictures produced. With an illumination range of 9 to 100,000 lux (the manual suggests "more than 300 lux" as the optimum illumination level), both indoors and out, in our brief test the camera produced videos of impressive clarity and consistency.

Likewise, in playback and connected to a television, to this reviewer's eyes the CCD-V5 performed as well as the big boys of VHS. While pre-recorded cassettes are not a strength of the format, they are out there. Sony as well as other 8-mm manufacturers go to some special efforts to let owners know about currently available and new releases.

A feature of the CCD-V5 that seemed to us a bit fussy—a mountain capable of bringing forth a molehill, if you will—is the unit's titling capability. Essentially the feature allows the camera to "memorize" a title written on a card, and then superimpose it over a scene in one of eight colors. It's a sophisticated capability, but requires three special controls and two pages of directions in the manual. Still, for the dedicated video enthusiast, the title function, once mastered, not only will make for a more professional program, but could backstop the always fallible human memory. With the title as part of the tape, mixing up vacation trips or weddings years after the event will be less likely.

A feature missing here is any kind of frame-count display, and that seems unfortunate. We'd gladly trade the title capability for an accurate tape counter. But perhaps the choice was made on the basis of the CCD-V5's potential user. This is definitely a home-video unit: It's fun, easy to operate, and requires a minimum of knowledge and attention; in short, it's virtually foolproof. In fact, in the 8-mm format, even fools can have some fun.

Getting Personal

Whatever doubts remain about 8-mm video, Sony Corporation appears to have full confidence in the format. At the Consumer Electronics Show this past summer in Chicago, the company unveiled a new line of 8-mm products that it hopes will do for video what the famed Walkman has done for portable audio.

The concept is "personal video," and the most intriguing of the three products introduced under that heading is the *Video Walkman (GV-8)* which should be on the market by the time your read this, or shortly thereafter. About the size of a hardbound book (five-inches wide, two-and-a-half-inches deep, and-eight inches high), the Video Walkman is a battery powered, handheld TV/VCR combination with re-

8mm Video Walkman

cording, time-shift, and playback capability. In the extended mode, the 8mm cassette can provide up to four hours of either record or playback time.

Weighing about two-and-a-half pounds, the GV-8 operates from either AC or DC power, or from rechargeable nickel-cadmium or alkaline batteries when used with an optional external battery pack. Despite its small size, the video portion of the system offers high-speed picture search; a linear time counter with tape position displayed in hours, minutes, and seconds; a one-day/one-event timer; and a power-off timer. The unit can also be connected to a large-screen monitor or TV.

Mini CCD Camera

8mm Desk Top Monitor/VCR

Its television component features a built-in VHF/UHF tuner, a telescoping antenna, and a three-inch (measured diagonally) color LCD screen with an "active matrix system for superior sharpness, contrast, and color purity." There's also a backlight behind the screen. The GV-8 Video Walkman has a suggested retail price of $1,300.

Other products developed as 8-mm "personal video" equipment include a desktop TV/VCR (*EV-DT1*, $1,700) and a basic color video camera (*CCD-G1*, $750). The EV-DT1 features a five-inch Trinitron color monitor and a 8-mm VCR with tuner and timer capable of seven-day/three-event time-shift recording. The unit includes a remote control and features on-screen programming display. ■

Gizmo/Bytes

Fisher Hi-Fi To Go Portable Audio Unit

Among other things we wish the consumer-electronics industry would standardize is a universal name for the portable audio systems that have proliferated during this decade. "Boom box" certainly won't do, especially as applied to the elegant new *Hi-Fi To Go Audio Unit (PHD815)* from the Fisher division of *Sanyo Fisher (USA) Corp. (1200 W. Artesia Blvd., Compton, CA 90220)*. The company says the product emphasizes "convenience features and upscale design," including "sculpted speaker enclosures," a detachable two-way speaker system, CD-output jacks, and AC/DC operation. The PHD815's dual-cassette system includes a sequential play function, which allows playback of two cassettes in uninterrupted succession and auto-reverse playback in the unit's "A" deck. There's also an AM/FM-stereo quartz-synthesized tuner with station presets and an autoscan function. A five-band graphic equalizer and Dolby Noise Reduction round out the "upscale" package. Price: $439.95.

CIRCLE 55 ON FREE INFORMATION CARD

Portable Audio System

Dial-It Cordless Tone Generator

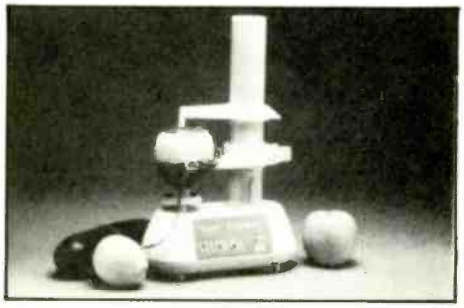
For those telephonic diehards who refuse to get with it and go completely electronic, or for those who, through no fault of their own, find themselves stuck at a rotary or non-tone-dial phone, *Dictograph Corp. (37625 Walden Ave., Lancaster NY 14066)* has the *Dial-It Cordless Tone Generator (100)*. Quartz-crystal controlled, the device provides access to beeperless answering machines, computers, pagers, and dictation systems. Besides a standard telephone keypad, the Dial-It has, as Dictograph puts it, "four special buttons for access to new services provided by phone companies and computer services in Europe. It's coming to North America and it's a new trend-setting feature never before offered on tone generators." By "it" we guess what's meant are those "new services." If you want to be prepared for the future, the gold anodized-metal Dial-It is apparently the tone generator to have. Price: $19.95.

CIRCLE 56 ON FREE INFORMATION CARD

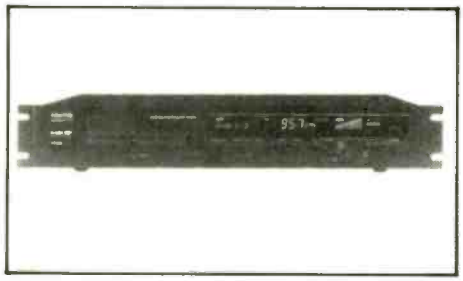
Cordless Tone Generator

Gizmo/Bytes

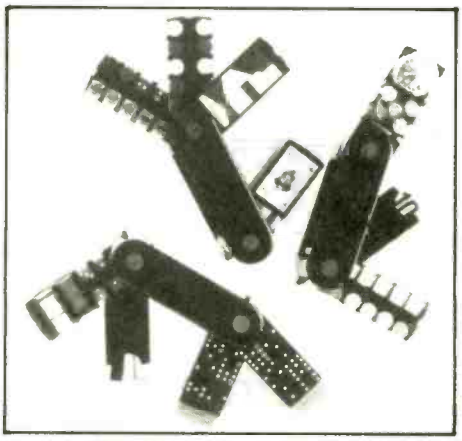
Video Light Meter



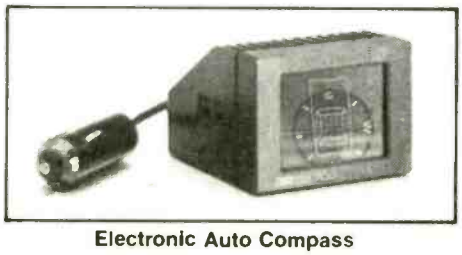
Automatic Fruit and Vegetable Peeler



Gamma Tuner



Uovo Nuovo Executive Toy



Electronic Auto Compass

Packtronics Video Light Meter

If you've recently made the switch from photography to *videography* and miss your old accessories and equipment, *Photo Systems, Inc. (7200 Huron Dr., Dexter, MI 48130)* has a product worth noting. From the firm's Packtronics division, it's a *Video Light Meter (LX-1)*. Most camcorders have some kind of light-level indicator system built in, but Photo Systems maintains, "the best way to determine if the lighting is right is to measure the light with a lux meter." The LX-1 uses a "silicon blue-sensitive photodiode" that provides a measuring range of approximately 10 to 50,000 lux. The meter range can be adjusted at three levels (× 10, × 100, and × 1000), with the unit's LCD indicating which measuring level to use. There's also a HOLD button to freeze the meter reading; power is supplied by a single 9-volt battery. Price: $190.95.

CIRCLE 57 ON FREE INFORMATION CARD

Automatic Fruit and Vegetable Peeler

We've never really been sure what the culinary term "julienne" means, but *Hammacher Schlemmer (147 E. 57th St., New York, NY 10022)* says this *Automatic Fruit and Vegetable Peeler* will do it. "Julienne," that is, along with automatically peeling any firm, flesh fruit or vegetable, "neatly and in seconds." A medium-sized apple, for example, will be evenly peeled in some 17 seconds, "wasting little or no inner flesh." Stainless-steel cutting blades (six are included with the unit) follow the contours of any fruit or vegetable, which in turn will allow the user to "prepare shoestring potatoes, citrus zests, skinless fruit pies, and perfect garnishes." Price: $44.50.

CIRCLE 58 ON FREE INFORMATION CARD

Nikko Gamma Tuner

There may be a passing of an era involved in the new *Gamma Tuner (G-400)* from *Nikko Audio Products (5830 S. Triangle Dr., Commerce, CA 90040)*. It seems Nikko's "variable high blend control" uses a rheostat that "increases apparent sensitivity by 'squeezing' upper frequencies." As a result, in its uppermost position, "there is virtually no stereo separation of the higher frequencies and at its lowest position stereo separation is maximized." Hence, goodbye "stereo/mono" switch on the G-400. Which we guess is like when manufacturers stopped including 78 and 16 rpm's on standard turntables. Other G-400 futuristic features include ten-station preset on the tuner's FM/AM bands, five-second station memory scan, muting, narrow/wide IF selector, seek, auto tuning, and even old-fashioned manual tuning. The station memory back-up is good for up to four days if there's a power outage or the unit is unplugged. The Gamma 400 is described as a "19-inch rack-mountable" unit. Price: $440.

CIRCLE 59 ON FREE INFORMATION CARD

Plus U.S.A. *Uovo Nuovo*

Don't ask for a translation of *Uovo Nuovo*; we're not even sure what the product it names is. From the hyperactive design department of *Plus U.S.A. Corp. (10 Reuten Dr., Closter, NJ 07624)*, it's described as an *Executive Toy*, a concept on which we reserve comment. The *Uovo Nuovo* encases fold-in elements similar to the famed Swiss Army Knife. There's a diminutive roulette set-up, poker set, and a domino set that includes checkers and dice. There's also a survival-kit version featuring compass, thermometer, fish line, string, flashlight, hooks, and sinkers. It goes without saying that fans of this kind of thing should really go for the hook, line, and sinker aspect. Price: $14.95.

CIRCLE 60 ON FREE INFORMATION CARD

Electronic Auto Compass

If we're ever involved in an emergency evacuation that requires driving over miles of unmarked terrain, we hope we're fortunate enough to be in a vehicle equipped with the *Electronic Auto Compass* offered by *Hammacher Schlemmer (147 E. 57th St., New York, NY 10022)*. That practical navigation aid uses "the quadrature circuitry used on-board commercial aircraft." It features a 360-degree graphic display of the vehicle's heading, and includes a separate direction sensor mounted on dashboard or windshield. Plugged into a cigarette lighter, the compass will measure the earth's magnetic field in two directions, automatically compensating for stray magnetic fields from other sources and calculates position within an accuracy of 1.45 degrees. Price: $52.95.

CIRCLE 61 ON FREE INFORMATION CARD

Gizmo/Bytes

Case Logic 120 Cassette Case

If you're a really big fan of portable audio, you should know about the big *Audio Cassette Carrying Case (CL-120)* from *Case Logic, Inc. (6930 Winchester Circle, Boulder CO 80301)*. As the product press release puts it, the CL-120 can store "10,000 miles of music," which works out to be 120 boxed audio tapes. The bag features plastic trays, foam padding, and a nylon shell, and it can be carried either with an adjustable shoulder strap or built-in handle. The entire case can be zippered closed. As for that "10,000 miles of music," as Case Logic figures it: A CL-120 fully stocked with home-recorded C-90 cassettes will provide access to as much as 180 hours of music. At an average speed of 55 mph, a listener could drive nearly 10,000 miles (more precisely 9,900 miles) and never hear the same selection twice. We guess that's why the company is called Case Logic. Price: $29.95.

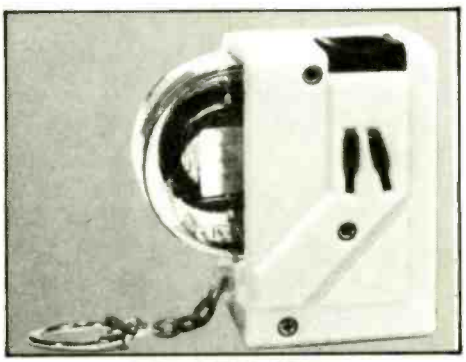
CIRCLE 62 ON FREE INFORMATION CARD

Audio Cassette Case

Fascinations Movie Viewer

It's barely tech, let alone high-tech, but as an item newly introduced to the novelty and premium market it earns points for following the adage, "if you've got a lemon, make lemonade." The *Fascination Movie Viewer* uses Super-8 footage (cartoons, travelogs, science films), which we thought had been rendered commercially superfluous by that medium's gradual disappearance. Battery powered, the unit projects endless-loop films as the viewer holds it to the eye. Primitive but effective, the unit is sold with one film, with alternate selections priced at around $2.95. The Movie Viewer's manufacturer, *Fascinations (309 S. Cloverdale, D-47, Seattle, WA 98108)* doesn't sell retail, but the product is widely distributed. Price: $6.95-$7.95.

CIRCLE 63 ON FREE INFORMATION CARD

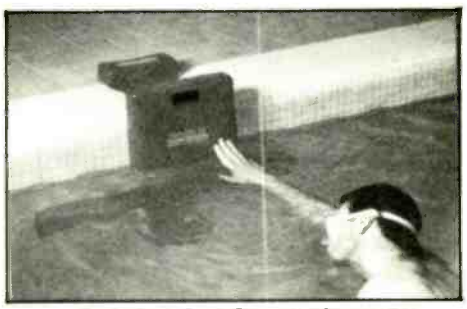


Super-8 Movie Viewer

Swimtech Lap Counter/Computer

Better swimming through computers might be the slogan of *Swimtech (1616 17th St., Suite 360, Denver, CO 80202)*. The company has developed an aquatic *Lap Counter/Computer* that keeps track of the basic unit of competitive and training swimming sports: the lap. A quick tap turns the computer on and it can count laps in increments of one or two. At the completion of a lap, the swimmer taps the unit again and the LCD freezes for five seconds (allowing a quick check of progress). Out of the water, the swimmer can check total-time, average-lap, fastest- and slowest-lap, total-lap, and calories-burned calculations. There's even a "lockout" feature to prevent "double clocks or bogus readings." Price: $119.95.

CIRCLE 64 ON FREE INFORMATION CARD

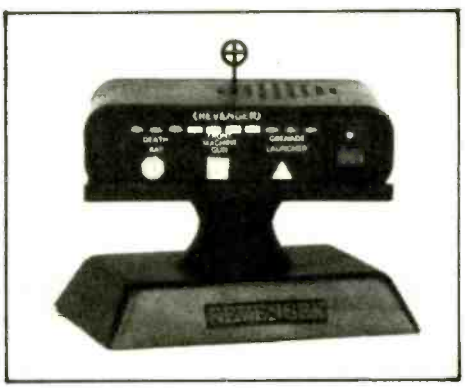


Swimtech Lap Counter/Computer

Desk Top Office Revenger

Readers may recall The Revenger (*GIZMO*, June 1988), a pocket-sized sound-effects unit offering a trio of aggressive explosion noises ideal for zapping enemies. Having achieved fame with a unit that looks like a miniature radar detector, the item's manufacturer, *Express Yourself, Inc. (1800-A Associates Ln., Charlotte, NC 28217)*, has decided to go upscale with a *Desk Top Office Revenger*. Mounted on a weighted swivel base and newly equipped with sight, crosshair, and snub-nose barrel, the office model offers the original Revenger sound effects: machine-gun-burst, grenade-launcher, and death ray-noise. According to Express Yourself, Inc., "no boardroom, manager's desk, or reception area is complete without one." Price: $25.

CIRCLE 65 ON FREE INFORMATION CARD

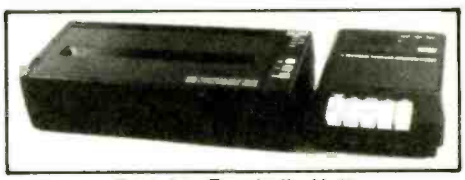


Desk Top Revenger

Citizen Portable Fax Machine

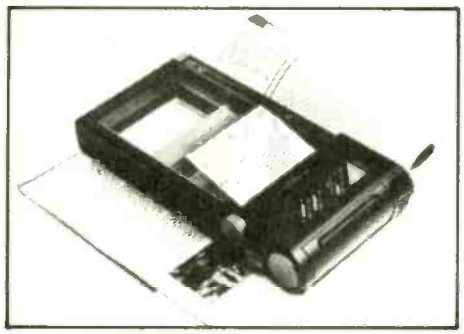
Facsimile transmission has grown enormously in just the past 18 months. With an eye toward that expansion, *CBM America Corp. (2999 Overland Ave., Los Angeles, CA 90064)* has introduced a new modular, portable facsimile machine that can do double duty as a copier. The *Citizen CBM Fax* weighs a mere five pounds and operates with its own internal rechargeable batteries, or it can draw power from a 12-volt vehicle battery or any domestic or foreign AC-power source. Transmission speed is less than a minute. CBM plans to offer a range of optional accessories, beginning with an answering machine that will receive either a message or a fax. The CBM Fax features fine or normal resolution, half tones, auto contrast control, automatic or answer mode, and can handle standard letter-sized sheets. The unit comes with a separate power transformer, line-connection cables, and a roll of thermal recording paper. Price: $1,195.

CIRCLE 66 ON FREE INFORMATION CARD



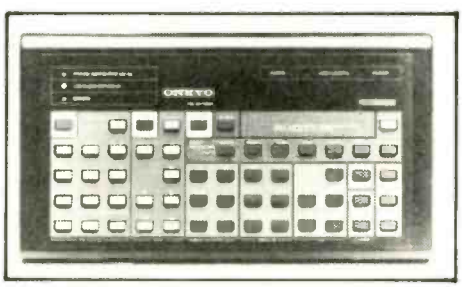
Portable Facsimile Unit

Gizmo/Bytes

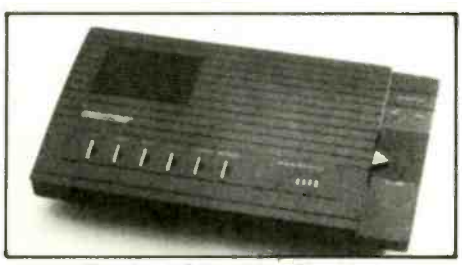


Personal Portable Copier

Hand-Held LCD TV



Universal Programmable Remote



Tapeless Answering Machine

Ricoh Personal Portable Copier

As the absolute bulk of copied material increases, the size of copying machines appears to be shrinking. The *Ricoh Corp. (5 Dedrick Pl., West Caldwell, NJ 07006)* has joined the marketing fray with its *Personal Portable Copier (MC50)*, described as being about the size of a small notebook. The unit, powered by either AC current or batteries (included), will copy from thermal or plain paper as well as transparent sheets. The MC50 is placed directly over the image to be duplicated, which can be previewed through a viewing glass. The copied image will be the same dimensions as the window, 3⅞ inches by 6½ inches. In contrast to other small copiers, it's not necessary to run the MC50 over the material being copied, which according to Ricoh results in "sharp, distortion-free images." Copying takes about 15 seconds. A couple of other Ricoh products, introduced in conjunction with the MC50, expand the copier's uses. An "image controller" (IM-A) which interfaces between a personal computer and the MC50 allows the portable copier to duplicate halftones, reduce or enlarge the original image, produce reversed copies, transforming black to white or vice versa, adjust copy density, and "enlarge or reduce specific sections of the original material." A second add-on, the IM-F "facsimile interface" enables the MC50 to function as a facsimile transceiver. Price: To be announced.

CIRCLE 67 ON FREE INFORMATION CARD

Panasonic Scientific Calculator

We don't know if the computer and the calculator have done away with chalk and blackboard in laboratories in this country, but a new *Scientific Calculator (JE-554U)* from the *Panasonic Co. (One Panasonic Way, Secaucus, NJ 07094)* sounds as if it should. The hand-held unit is equipped with a ten-digit LCD readout and performs 166 statistical, mathematical, scientific, and computer functions. The calculator also incorporates a 128-step programming mode, eight metric-conversion functions, and (presumably for the absent-minded scientist) an automatic power-off feature. Price: $39.95.

CIRCLE 68 ON FREE INFORMATION CARD

Citizen Hand-Held LCD-TV

Citizen was a pioneering brand in the mini-TV market, but dropped by the wayside. Now, *CBM America Corp. (2999 Overland Ave., Los Angeles, CA 90064)* is returning to the field with a new *Hand-Held LCD-TV (TC-53-05)*. The set, weighing less than one pound, offers a built-in backlight, a 23-inch extending antenna, a 2.5-inch diagonal screen, and front-mounted tuning for VHF/UHF stations. There's also a flip-out stand, a hood for cutting glare, and reflection and a three-way power system, which includes portable use with four "AA" batteries for up to four hours of continuous mini-TV viewing. Price: $299.95.

CIRCLE 69 ON FREE INFORMATION CARD

Onkyo Universal Remote Control

Among the first brands out of the starting gate with a universal remote control for audio/video equipment was *Onkyo (200 Williams Dr., Ramsey, NJ 07446)*. Now the firm has introduced an update, the *RC-AV10M Universal Programmable Remote Control*. Featuring 55 separate functions, the unit can control over six different components. Price: $80.

CIRCLE 70 ON FREE INFORMATION CARD

Code-A-Phone Tapeless Answering Device

We get nervous when companies talk about "the ultimate product," but *Code-A-Phone (16261 S.E. 130th, Clackamas, OR 97015)* has put that label on its new *All-Digital Telephone Answering System (6200)*. The unit uses integrated circuits to record both outgoing and incoming messages, and offers such sophisticated features as selective message save/erase, an instant message finder, and "the smart message counter," which distinguishes between "internal" messages, left by members of the household, or work mates, and incoming calls. There are also 17 beeperless remote functions, a toll-saver, and announcement breakthrough. Introduced at the summer Consumer Electronics Show, the 6200 should remain the "ultimate" digital answering device until at least the next CES. Price: $149.95.

CIRCLE 71 ON FREE INFORMATION CARD

Gizmo/Bytes

Panasonic Clock Radio

If you're interested in a clock radio to have *around* the house, there's a new one that should fit the bill—literally. That would be the *RC-70 Clock Radio*, which the *Panasonic Co.* (*One Panasonic Way, Secaucus, NJ 07094*) describes as being "housed in a contemporary, sphere cabinet." The sphere is pretty timeless, but that black-and-white bedside model is convincingly contemporary. The green LCD features a two-level dimmer control and clock features include hour/minute time settings, a doze and sleep function, radio or buzzer alarm, and a power-failure indicator. A battery back-up system keeps time internally, assuring correct time display when power resumes. Price: $42.95.

CIRCLE 72 ON FREE INFORMATION CARD

AM/FM Electronic Clock Radio

Aiwa Digital Headphone AM/FM Stereo Recorder

Aiwa America, Inc. (*35 Oxford Dr., Moonachie, NJ 07074*) is calling its new *Digital Headphone Stereo (HS-J800)* "the first to develop an IC tuner pack incorporating digital synthesized tuning and an LCD function readout." The digital readout displays radio-station frequency, AM/FM mode, tape direction, and more. The HS-J800 features stereo-recording capability and is equipped with a detachable stereo microphone. There's also a one-hour rechargeable battery good for up to three hours of operation. Cassette features include auto reverse, Dolby B noise reduction, and metal/normal tape selection. Price: $240.

CIRCLE 73 ON FREE INFORMATION CARD

Digital Headphone Stereo Cassette Recorder

Sharp Microwave Convection Oven

It seems a minuscule step for mankind, but the *Sharp Electronics Corp.* (*Sharp Plaza, Mahwah, NJ 07430*) maintains it's a giant step for a favorite snack food. The advance in question is a new "popcorn sensor setting" added to the firm's *Carousel II Microwave Convection Oven (R-9H80)*. It seems "microwave popcorn is the fastest-growing segment of the popcorn business," and Sharp is responding by adding a special setting to its "Deluxe E.S.P. (Electronic Sensory Processor)" microwaves. Somehow, it seems kind of incongruous to buy a full-size microwave oven to prepare small bags of popcorn. If microwave-popcorn consumption continues growing, a microwave corn-popper would seem a product destined for introduction. Price: $599.95.

CIRCLE 74 ON FREE INFORMATION CARD

Telephone Message Stopper

In this, the age of the answering machine, one of life's little irritations is racing to answer the phone and ending up shouting over the recorded outgoing message as you grapple for the off control. The *Message Stopper* from *Jasco Products Co., Inc.* (*P.O. Box 466, Oklahoma City, OK 73101*) promises to put an end to the answering machine dash. The simple device stops the answering machine when the phone or any extension instrument is answered. The answering unit automatically resets. The message stopper also prevents others from overhearing or interrupting a phone call, and guards against the interruption of facsimile or modem transmissions caused by someone picking up an extension instrument to make a call. Price: $19.99.

CIRCLE 75 ON FREE INFORMATION CARD

Telephone Message Stopper

Braun Multipractic Deluxe Food Processor

Are you, or is someone you know, a dedicated serious cook? That's the target consumer for the *Multipractic Deluxe Variable Speed Control Food Processor (UK 40)* from *Braun, Inc.* (*66 Broadway, Rt. 1, Lynnfield, MA 01940*). The company calls this "the ultimate kitchen tool for the cook who demands superior performance." The UK 40 slices, shreds, cuts, grates, and can also knead up to two loaves of bread. An adjustable disc system allows one disc with five cutting inserts to perform the same functions as 32 separate discs. In preparing French Fries alone, the Multipractic Deluxe offers no fewer than 18 slicing thicknesses and 11 different "French fry/julienne" settings. Price: $140.

CIRCLE 76 ON FREE INFORMATION CARD

Multipractic Food Processor

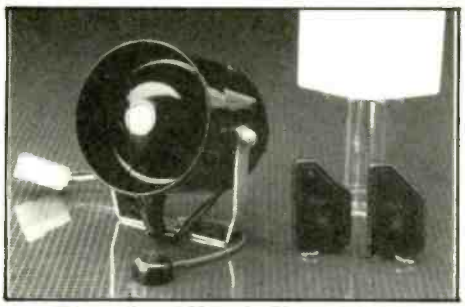
Gizmo/Bytes

Four-Head VCR

Hitachi Four-Head VCR

On-screen programming information was the big news in VCR's a couple of years back, but now other "bells and whistles" have overtaken it as hot options for home video. But that hasn't stopped *Hitachi Sales Corp. of America (401 W. Artesia Blvd., Compton, CA 90220)* from developing a new *Four-Head VCR (VT-3050)* with no less than 16 screens of directions for programming the unit, troubleshooting suggestions, and information ranging from setting the clock to offering a toll-free number for service and repair locations. The data is even color-coded, with instructions on a green background, the troubleshooting guide on a red screen, and feature information on a blue screen. Price: $429.

CIRCLE 77 ON FREE INFORMATION CARD



Recreational Vehicle Alarm System

Serpico Recreational Vehicle Alarm

Sometimes recreational vehicles, or RVs, are called "homes on wheels." But like any homeowner, RV owners are increasingly concerned with security. The *Serpico* company *(5347 Progress Blvd., Bethel Pk., PA 15102)* is introducing a *Remote Control Recreational Vehicle Alarm System (RV-2)* that appears to be an initial success. Initial in that the firm says it features "ESS" (electronic shock sensor), "IVM" (intelligent voltage monitoring), "PIR" (passive infrared detection), and, of course, an "LED" indicating the system status. Beyond the letters, the RV-2 features a 120-decibel siren and two anti-scan transmitters. Designed for installation by the RV owner, Serpico offers a number of optional add-ons to further secure the homes on wheels. The system can also be used in campers, delivery vehicles, vans, and mini-trucks. Price: To be announced.

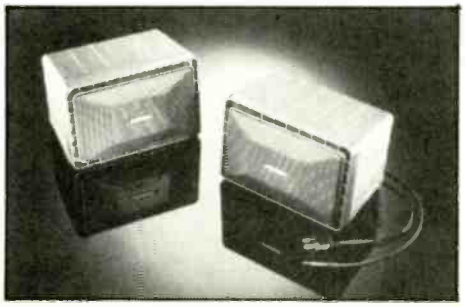
CIRCLE 78 ON FREE INFORMATION CARD

Monitor Anti-Glare Filter

Workstation Anti-Glare Filters

With over 15 million CRT-based terminals currently in use in this country, *Fellowes Manufacturing Co. (1789 Norwood Ave., Itasca, IL 60142)* is right on time with its introduction of a popularly priced *Workstation Anti-Glare Filter*. Lightweight, the unit hangs from the top of a computer monitor with two weighted clips. Besides cutting down on screen glare, the filter gives screens more contrast, in both monochromatic and color monitors. Four sizes are available for makes and models ranging from a 9-inch Apple MacIntosh to a 15-inch IBM PS/2. Price: $24.95–$29.95.

CIRCLE 79 ON FREE INFORMATION CARD



Roommate II Powered Speakers

Bose Roommate II Powered Loudspeaker

Need a new roommate? The *Bose Corp. (The Mountain, Framingham, MA 01701)* thinks you do, namely the company's new *Roommate II Powered Loudspeaker*. That update of the very popular Roommate offers an AC/DC-power jack with removable AC-power cord, a new "fiberglass reinforced injected styrene cabinet," and revised equalization and compression circuitry, providing "smoother response and better high end performance." All that in a package weighing 10.5 pounds. Price: $279.

CIRCLE 80 ON FREE INFORMATION CARD

Compact Facsimile Unit

Sharp High-Speed Facsimile

Aimed at the small-business or home-office user, the new *High-Speed Facsimile (UX-160)* from *Sharp Electronics Corp. (Sharp Plaza, Mahwah, NJ 07430)* sounds as if it's a compact but multi-featured communications center. With eighteen-second transmission speed and vertical resolution of 391 lines-per-inch, the UX-160 can transmit photos and half-tones as well as printed and written documents. Its built-in telephone features automatic dialing for up to 87 numbers, with a dozen frequently called numbers accessible with single-touch dialing. It can also be programmed to dial a second number if the first one is busy. The UX-160 is compatible with Group 2 and six-minute North American FM facsimiles and offers "turnaround polling," which Sharp explains, "allows networked facsimiles to exchange information during low-rate evening hours." Price: $2,299.

CIRCLE 81 ON FREE INFORMATION CARD

OF MICE, AND MORE

Cursor keys have been around since the dawn of computer monitors. But what alternatives are there, and who makes the best? We cover the lot here and separate the mice from the men!

By Jeff Holtzman

ONE REASON PC'S ARE GREAT IS THAT COMPUTER power continues to spiral upward, while price goes in the opposite direction. Nowhere is that more apparent than in the field of microcomputer graphics. For example, when the IBM PC was first released in 1981, the CGA was the best (and the only) graphics adapter money could buy. In its "high-resolution" mode, it could fit 640 dots on each of 200 lines, but only in two colors. You could also get four colors in a 320 × 200-pixel mode.

Nowadays, however, you can get graphics adapters with resolutions approaching that of engineering workstations: 1000 × 800-pixels and even more.

Of course, graphical power is nothing without an appropriate tool for manipulating graphic elements. So in this article we'll look at several such tools (generically called "pointing devices"), including mice, trackballs, and others. And we should point out that graphics programs are not the only ones that can benefit from pointing devices. Many text-mode programs (QuickBasic 4.0, DESQView 2.0, GrandView, and BookShelf, for example) now come with interfaces that allow you to use pointing devices to accomplish your tasks.

Pointer Basics

If you're picky about the feel of your keyboard, you're liable to be even pickier about your pointer because of the sensitive nature of the tasks to which pointers are usually applied. When you're moving a cursor on a screen with 1000 dots in both directions, you want something that doesn't jerk every time you move it. Jerkiness may be due to a poorly designed or manufactured device, but it may also be due to the size or shape of a device, and how it fits in your hand. So, if at all possible, try before you buy.

You'll also want to consider several other points before buying: the interface type, the underlying technology, the included documentation, the number of buttons, the packaged software, and the device's power source.

The Interface

Many pointing devices come in two versions: serial and bus. A serial version requires use of a standard RS-232C serial port; a bus version provides its own interface card. Some people feel that bus versions provide better performance than serial versions. One company—MicroSpeed—has introduced an adapter card, called the PDA, that allows you to use several varieties of serial mice—Microsoft, LogiTech, etc.—as bus mice. The PDA is discussed later on in this article.

Microsoft has a third interface method, called the InPort, that is provided on the company's Mach 10 and Mach 20 accelerator cards, on accelerator cards from PC Technologies, and on other devices from other companies. The advantage of an InPort mouse is that it requires neither a serial port nor an extra expansion slot just for the mouse interface. IBM introduced a new hardware mouse interface with the PS/2 line of computers; some, but not all, vendors support the PS/2 interface.

Mechanisms

The underlying technology affects the overall feel and usability of a mouse. For example, most mice are opto-mechanical devices in which slotted wheels interrupt beams of light to provide horizontal and vertical motion information. Depending on the environment in which they're used, dust may collect inside the mouse and impair operation. So an opto-mechanical mouse probably may need to be cleaned occasionally.

On the other hand, a purely optically driven device (like MSC's PC Mouse) has no moving parts, so it doesn't require cleaning. However, it does require a special pad with etched lines that reflect light in various ways. If your desk tends to get messy, keeping track of the pad can be a chore. On the other hand, after you find it, you can just plop it down on top of whatever is already there.

Documentation

For a product so easy to use as a pointing device, documentation may not seem important. That's true if all you're going to do is plug the device in and use it. However, if you want to do anything more—perhaps write your own graphics software or create a menu system for your favorite word processor—you'll need more information. Some manufacturers provide what you need with the device; others charge extra.

Further Considerations

The optimal number of buttons on a pointing device is a hotly-debated theoretical issue, but most devices today seem to come with three buttons, presumably because you can simply ignore the extra buttons if your software does not use them.

Many pointing devices come with bundled software, including CAD (Computer Aided Drafting), drawing and painting, and desktop publishing programs, as well as special software that allows you to build menus for running programs that don't have built-in support for pointing devices.

As for power source, some pointers require only a few milliamps of current, which they can pick up from the serial port they're attached to. Others require a separate power transformer, which increases cable clutter. At least one mouse (the Manager Mouse Cordless) has a built-in rechargeable battery. Of course, pointers with a bus interface need no external power source. We'll note what is supplied with what in the round-up that follows.

Microsoft

It wasn't long ago that only a few companies sold pointing devices for PC's. Now there are at least half a dozen, including two of the largest microcomputer companies (Microsoft and Tandy). We examined several of the more-popular devices currently on the market. What follows are our observations on those devices.

The LogiTech mouse has three buttons, and comes with excellent software, including a complete text editor and a menu-generating program that allows you to use the mouse with software (your favorite word processor, for example) that doesn't normally allow the use of a mouse.

The two-button Microsoft mouse is a *de facto* industry standard, especially the underlying software interface (which allows the mouse to talk to your programs). For that reason, most companies selling PC pointers provide software—and in some cases hardware—emulation of the Microsoft Mouse. The mouse is available in serial (which also runs on PS/2's), bus, and InPort versions; it is also available with various software packages. Check with your dealer for the current configurations.

The feel of the Microsoft mouse is first rate. The buttons depress easily, providing a nice audible click, and the mouse moves smoothly with neither jerkiness nor sliding. The weakest point is the documentation. You must pay an additional $25 for the menu-generator and detailed information on the mouse function calls.

LogiTech

The three-button LogiTech mouse doesn't quite match the look and feel of the Microsoft mouse, but it far outshines it in supplied software.

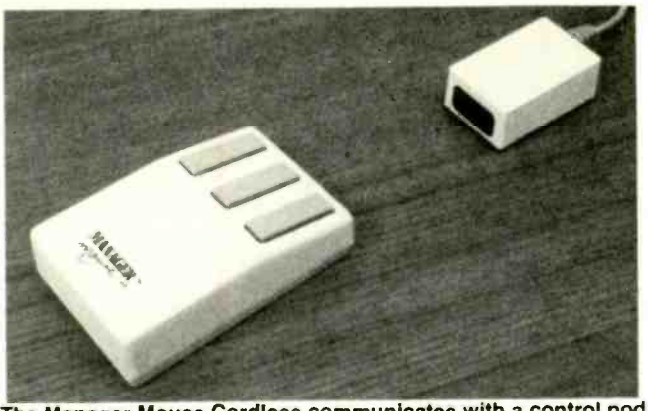
Not only does LogiTech include a menu generator (and numerous menus for popular applications), the company also includes programs that emulate several varieties of mice (including Microsoft's), and a complete mouse-controlled text editor called Point. Overall, it is our runner up in the mouse competition.

MSC's PC Mouse has no moving parts; rather, a pair of LED's bounces light off a special pad. Then a pair of photodiodes detect that light, providing motion information for the mouse. The result is smooth, reliable operation.

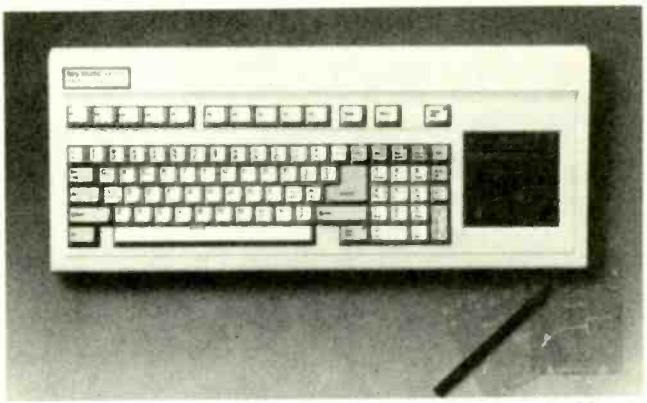
Mouse Systems Corp.

Formerly known as Mouse Systems Corporation, MSC sells one of the few optical mice on the market today. The PC Mouse has three buttons, and its felt pads allow it to glide effortlessly over its 8 × 10 inch pad.

It includes a menu generator and well-written documentation, including a technical reference manual. Overall, we like the feel of this mouse better than the Logitech, but find that we can operate the Logitech (and the other mice) in about half the real estate occupied by the PC Mouse's pad.



The Manager Mouse Cordless communicates with a control pod via infrared LED's. Due to a "sleep" mode, the rechargeable battery should last for several days between charges.



The KB5153 starts with a basic AT-style keyboard, and adds a programmable digitizing pad. Plastic overlays show which portion of the pad emulates keystrokes, and which emulates mouse motions. You can use the setups provided by KeyTronics, or design your own specific layouts.

Numonics

The Manager Mouse Cordless is a nice idea with an imperfect implementation. As its name suggests, this mouse communicates with a separate receiver via infrared LED's and photodiodes. The mouse itself has three buttons and a front-mounted charging jack. In typical use, a charge should last for about three days. You can operate the mouse while it is charging, but the stiff charging cord makes such operation difficult. The receiver itself requires power from a power transformer, so you can't use the Manager Mouse without a source of 117 VAC, so lap-top operation is out.

In operation, the mouse has a good feel (without the charging cable attached), but the software drivers supplied with the device were buggy. For example, in both AutoSketch and Dr. Halo, sensitivity provided by the drivers was too low for convenient use.

Documentation is adequate, but no menu software is supplied or even available.

Tandy

At $50, Radio Shack's serial mouse is the cheapest on the market. Its documentation is minimal, and no software is included—not even the requisite mouse drivers. According to the company, Radio Shack's versions of MS-DOS come with the mouse drivers; if your version of DOS has no mouse drivers, a local Radio Shack store should provide them to you free of charge.

Because of its low price, I expected that the feel and operation of the mouse might be lacking—but fortunately, I was wrong. The feel of this mouse is easily competitive with the others discussed here. As for software, I had no trouble running the mouse using the MOUSE.COM driver that comes with the Microsoft mouse, and with MicroSpeed's PDA driver (more on that following).

KeyTronic

The KB5153 is an AT-style keyboard with a digitizing tablet embedded in the right side. The digitizing tablet can be programmed to emulate regular keyboard keys, mouse motions, or both. Resolution is low in key-emulation mode, so you can press the pad with your fingers. In mouse mode, however, you use a plastic stylus to traverse the pad. KeyTronic supplies software drivers for running PageMaker and Ventura Publisher with the keyboard, a Microsoft mouse emulator, and other programs for creating your own sets of keyboard emulations.

The KB5153 is more expensive ($250) than the other devices discussed, but it needs no extra desk space. The keyboard itself has a nice feel: not as "clicky" as an IBM, but not mushy like most cheap clone keyboards. If you need a keyboard and a mouse, this quality product is worthy of consideration.

MicroSpeed

This company has been introducing one product after another during the past year. First came the FastTRAP, followed by the PC-Trac; followed by the PDA, a card for converting any serial mouse to a bus mouse.

The FastTRAP and the PC-Trac are both three-button devices built around trackballs. (Essentially, a trackball is a mouse lying on its back.) The advantage of a trackball over a mouse is that you don't need a clean surface on which to operate the device—you can even operate it on your lap!

The disadvantage is that some operations that are easily performed with a mouse, can be difficult with a trackball. For example, dragging, wherein you continually press a button while moving the mouse, is problematic, because it's hard to press a button and move the trackball simultaneously.

However, the MicroSpeed trackballs have special emulation modes that simplify dragging. You press the middle

The FastTRAP is nearly identical to the PC-Trac, but adds a vertically oriented trackwheel. The trackwheel may be used for 3-D CAD work or for emulating various keystrokes in other programs—simulating PGUP and PGDN, for example.

button (which is not normally used anyway), then press and release the "drag" button. The device then acts as if the button was still being pressed. To terminate drag mode, you press the drag button again.

Both devices emulate the Microsoft mouse in hardware, so software compatibility is no problem. In addition, they come with a program that allows ballistic gain control—a concept that MacIntosh users are familiar with. With ballistic gain control, motion sensitivity is adjusted on the fly, as you use the device. For example, moving slowly, you might have to move four inches to move the mouse pointer across the screen. Moving the mouse quickly, however, might require only two inches of motion. (Sensitivity is adjustable through software.)

The advantage of ballistic gain control is that for precise operations—editing pixels bit by bit, for example—you want maximum accuracy. But to activate a menu and save your file, speed is most important.

FastTRAP stands for Fast Tri-Axis Pointer; as you can see in the photo, the device differs from the PC-Trac through the addition of an additional vertically-oriented wheel, called a trackwheel, that allows operation in the third (Z) axis in 3-D CAD programs. In addition, the trackwheel can easily be configured for use in spreadsheets and word processors. In that case, rotating the wheel would simulate pressing the PGDN and PGUP keys (or any other keys that are convenient for your application).

The PDA (*P*ointing *D*evice *A*dapter) is a half-length card that plugs into an 8-bit slot. The PDA does two things: it allows you to convert just about any serial mouse into a bus mouse (thereby saving you a serial port), and it brings ballistic gain control to mice that don't have the capability—and presently no manufacturer of pointing devices for PC's other than MicroSpeed has ballistic drivers.

Lightgate

Remember Felix The Cat? Like the original, Lightgate's Felix is a would-be mouse killer that works like a cross between a joystick and a digitizing tablet. A single switch is mounted at the top of a post that you hold between your thumb and second finger (like a pencil); your first finger operates the switch.

The post moves in an area that is about one inch on a side; along the perimeter of that area are twelve "Hot Spots," areas that you can program to deliver simulated keystrokes (like a keyboard macro processor). You can activate the Hot Spots either alone or in combination with your keyboard's CTRL, ALT, and SHIFT keys, providing a total of 60 Hot Spots. Lightgate supplies files that program the Hot Spots for effective use of Lotus 1-2-3, AutoCAD, and other programs. You can also create your own easily.

In operation, Felix provides a one-to-one correspondence with the screen of whatever program you happen to be running. In other words, regardless of the program, when you move the Felix pointer to the upper left corner, your on-screen pointer will move to the upper left corner. When you move the Felix pointer to the lower right corner, your on-screen pointer will follow accordingly. That correspondence provides a comfortable frame of reference, unlike the typical mouse or trackball, use of which in comparison is like being in constant free-fall.

The device has a couple of faults, however. The documentation seems more interested in being "cute" than in supplying information. Second, the Felix driver software uses about 40K of memory, which is three to five times as much as what most mouse and trackball drivers use. Third, and most important, you must press the button on top of the post too far to get a response, and there is no feedback (click) to alert you when contact has been made. Also, the device has a separate power supply that increases cable tangle.

Still, because of the one-to-one correspondence between screen position and Felix pointer position, using the device is pleasant. If the device's faults are remedied, Felix may well become the mouse killer it aspires to be.

Products Discussed

Felix ($199; $149 for MacIntosh version): Lightgate, 6202 Christie Avenue, Emeryville, CA 94608; Tel. 415/596-2350.
CIRCLE 31 ON FREE INFORMATION CARD

KB5153 ($249): KeyTronic, P.O. Box 14687, Spokane, WA 99214-0687; Tel. 509/928-8000.
CIRCLE 32 ON FREE INFORMATION CARD

Serial Mouse ($119): LogiTech, 6505 Kaiser Drive, Fremont, CA 94555; Tel. 415/795-8500.
CIRCLE 33 ON FREE INFORMATION CARD

Serial Mouse ($150): Microsoft Corp., 16011 N.E. 36th Way, Box 97017, Redmond, WA 98073-9717; Tel. 206/882-8080
CIRCLE 34 ON FREE INFORMATION CARD

PC Mouse ($149): MSC Technologies, 2600 San Tomas Expressway, Santa Clara, CA 95051; Tel. 408/988-0211.
CIRCLE 35 ON FREE INFORMATION CARD

PC-Trac ($119 serial, $139 bus), FastTRAP ($149 serial, $169 bus), PDA ($69): MicroSpeed, Inc., 5307 Randall Place, Fremont, CA 94538; Tel. 415/490-1403.
CIRCLE 36 ON FREE INFORMATION CARD

Manager Mouse Cordless ($199): Numonics, 101 Commerce Drive, Montgomeryville, PA 18936; Tel. 800/247-4517.
CIRCLE 37 ON FREE INFORMATION CARD

Serial Mouse ($49.95), Radio Shack, One Tandy Center, Fort Worth TX, 76102.
CIRCLE 38 ON FREE INFORMATION CARD

Conclusions

With so many devices on the market, how does one choose among them? First and foremost is how the device feels to you. If the shape of your hand doesn't match that of a given pointing device, you'll never feel comfortable with it.

Software is another priority. Many pointers come with applications, menu generators, etc. LogiTech is the winner in that category, because its mouse comes with a complete text editor and also a menu generator. For slightly more, you can also get paint, publishing, and CAD programs. MSC's optical mouse also comes with a paint program and a menu generator.

Our personal favorite is the Microsoft mouse. Its small size and well-formed shape feel good, as do its "clicky" buttons. In fact, combined with MicroSpeed's PDA board, you have an unbeatable combination. ■

HANDS-ON REPORT

DIGITAL VOICE RECORD/PLAYBACK MODULE

An adaptable modular kit of parts brings computer-age gadgetry to the workbench!

AFTER A HARD DAY'S WORK, A HARried husband unlocks the front door to his home only to find that his wife is not home. He's not concerned however. Instead, he removes his coat, glances through the mail, and presses a button on a small plastic box. A familiar voice rings out, "Honey, I'll be back in 10 minutes. Picking up the kids at the skating rink. Freshen up and supper will be ready by six."

His wife had left him a recorded message in a *Digital Voice Record/Playback* unit that he built himself, mostly from a kit of parts. The project was the third that he had ever tried, and his friends now think he should head up the space program.

We don't agree with his friends, but we do know that you can build the same project, and others based on it, at a low cost but with maximum impact on your family and friends. If you want your friends to think that you should head up NASA, read on!

Specifications

The *Digital Voice Record/Playback Module (K2653)* can store up to 10–12 seconds of speech in its RAM memory. Voice quality of the played back sound does diminish with the length of the preset maximum playback time, but the voice is always intelligible.

The module requires a regulated 9-volt DC power supply. The standby power is 0.5 milliamperes. The playback maximum current drain of 300 milliamperes is mainly expended in the audio-output stage in delivering audio power to the loudspeaker. The maximum audio output is 2 watts into 4 ohms.

The schematic diagram of the module is shown in Fig. 1. Note that some of the symbols and terminology used there and in the Parts List differ from what you are used to seeing in **Hands-on Electronics**. That's been done to conform to the style used in the kit's parts list and printed-circuit board. For example, the kit's distributor used RV to indicate a potentiometer; in our magazine, we would denote such a part as R. There are numerous other changes, too. However, if you read carefully, there should be no problem in following the text and diagrams.

The basics of the module's operation are as follows: Sound is detected by condenser microphone MIC1 (see Fig. 1), an analog device, and the audio signal is sent to IC3 where speech, or any other sound, is digitally sampled at a rate determined by an internal clock. The volume and frequency variations of the audio signal are converted to digital-bit information that is sequentially stored in two RAM memories (IC1 and IC2). Those RAM memories can hold 10 to 12 seconds of information.

The quality of the audio reproduction is determined largely by the sampling rate. At the lowest sampling rate provided by the module, maximum storage time is achieved, but at the expense of audio quality. Higher quality audio is available by increasing the sampling rate, but doing that cuts the maximum message length proportionately.

Playback is essentially the reverse process. The RAM memories are *strobed* to output the stored bits of audio information in the sequence in which they were stored. The main chip (IC3) detects those bits and converts them into an analog, audio signal that can be amplified by IC4 and heard from the loudspeaker.

Assembling the Board

The Digital Voice Record/Playback Module comes complete with the PC board, and all of the parts that mount on it. See the Parts List. The builder supplies only the power supply or battery, cabinet, wire, miniature loudspeaker, and switches.

Putting together a printed-circuit board with all the parts supplied in kit form is the simplest approach to tackling a project, especially when the parts side of the board is silk-screened to identify the parts locations. Aside from the soldering errors that can plague any construction project, about the only thing that can go wrong is the misorientation of the integrated circuits or the

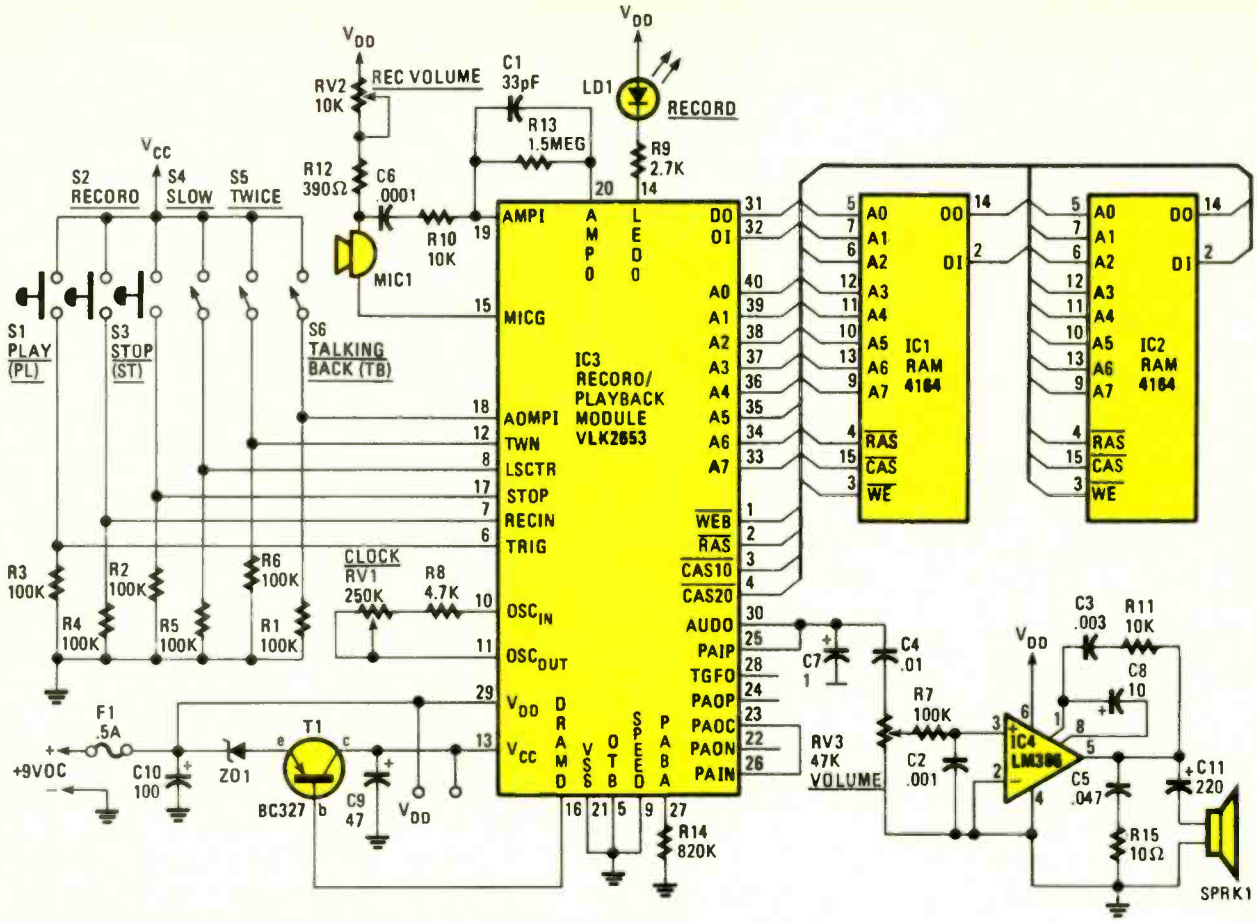
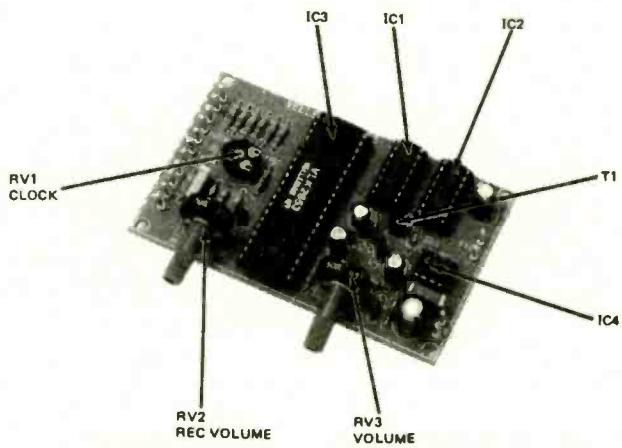


Fig. 1—The complete schematic diagram for the Digital Voice Record/Playback Module Kit with external circuitry added. All the designed features are included in this illustration.

electrolytic capacitors. A careful check of your work before applying power should turn up such errors before any damage is done.

Begin by mounting and soldering the smaller parts—the ¼-watt resistors, small capacitors; and the transistor; to avoid damaging the transistor, handle its leads carefully and don't force them into place. Follow up by mounting and soldering the IC sockets, big capacitors, and potentiometers. Finish up by installing the terminal pins. That's about ninety percent of the job. The board should now resemble the one shown in Fig. 2.



A view of the printed-circuit board after all the parts are mounted. What you see in this photo are the board and most of the parts that are supplied with the module kit Not shown are the LED and condenser microphone.

Testing the Circuit Board

Hook up the board as detailed in Fig. 3. Connect condenser microphone, MIC1, in the following manner: Connect and solder the tab on the metal shell to the microphone lead nearest to it and a short length of wire. That wire connects to terminal MIC– on the printed-circuit board. The remaining microphone lead (with the help of a short wire lead) connects to the MIC+ terminal.

Connect the LED to the printed-circuit board. Do not clip its leads. Connect the longer lead (anode) to the LD1+ terminal and the shorter lead (cathode) to LD1–.

Connect two short wires to the loudspeaker (SPKR1) and connect those to the LS+ and LS– terminals. Polarity is not important here—reversing the leads will not cause any ill effects.

Connect two single-pole, single-throw, pushbutton switches to the printed-circuit board. Connect one lead from S1 (PLAY) to the PL terminal and one lead from S2 (RECORD) to the RECORD terminal. The remaining two leads, one each from S1 and S2, connect to the COM terminal.

Check the connections you just made and the printed-circuit board itself. When you are satisfied that all of the

PARST LIST FOR THE DIGITAL VOICE RECORD/PLAYBACK MODULE

SEMICONDUCTORS
IC1, IC2—4164 64K × 1-bit DRAM integrated circuit
IC3—VLK2653 digital-voice integrated circuit
IC4–LM386 audio amplifier integrated circuit
T1—BC327 NPN transistor
ZD1—3.6-volt, ¼-watt, Zener diode

CAPACITORS
C1—33-pF, ceramic
C2—.001-µF, ceramic
C3—.0033-µF, ceramic
C4—.01-µF, ceramic
C5—.047-µF, ceramic
C6—.1-µF, ceramic
C7—1-µF, 16-WVDC, electrolytic
C8—10-µF, 16-WVDC, electrolytic
C9—47-µF, 16-WVDC, electrolytic
C10—100-µF, 16-WVDC, electrolytic
C11—220-µF, 16-WVDC, electrolytic

RESISTORS
(All fixed resistors are 1/4-watt, 5%)
R1–R7–100,000-ohm
R8—4700-ohm
R9—2700-ohm
R10, R11—10,000-ohm
R12—390-ohm
R13—1.5-megohm
R14—820,000-ohm
R15—10-ohm
RV1—250,000-ohm, flat PC-mount, trimmer potentiometer
RV2—10,000-ohm, vertical PC-mount, trimmer potentiometer
RV3—47,000-ohm, vertical PC-mount, trimmer potentiometer

OTHER PARTS AND MATERIALS
LD1—Light-emitting diode, red
MIC1—Microphone, condenser
Printed-circuit board, IC sockets, 15 PC-mount terminal pins, plastic shafts for RV2 and RV3, etc.

ADDITIONAL PARTS
(The following parts are required for this project but not supplied by the kit manufacturer)
B1—9-volt DC, 300-mA power supply, or six 1.5-volt D cells
F1—0.5-amp, 3AG fuse with in-line fuse holder
S1–S3—SPST pushbutton switch
S4–S6—SPST toggle or slide switch (optional)
SPKR1—Speaker, 2- to 5-in. diameter, 4-ohms or higher
Plastic or aluminum cabinet, wire, etc.

A complete set of parts that mount on the printed-circuit board, the printed-circuit board, condenser microphone (MIC1), and light-emitting diode (LD1) can be purchased as the Digital Voice Record/Playback Module Kit K2653 from Tapto Corporation for $61.95 which includes postage and handling. CO residents must add appropriate sales tax. Send order to Tapto Corporation, P.O. Box 44247, Denver, CO 80201; or call 1-800-873-8001 (to order only).

For a catalog of kits and other interesting products you can write to Tapto at the address above, or circle No. 82 on the Free Information Card in this issue.

connections are made properly, and that all parts are correctly soldered onto the printed-circuit board, install the integrated circuits in their sockets.

Connect a regulated 9-volt DC power supply to the printed-circuit board pads labeled 9VDC+ and 9VDC−. Pay careful attention to voltage polarity. The power supply should have an on/off switch and be rated at 300 milliamperes, or better. For safety sake, provide a 0.5-ampere fuse in the positive voltage lead between the power supply and the printed-circuit board.

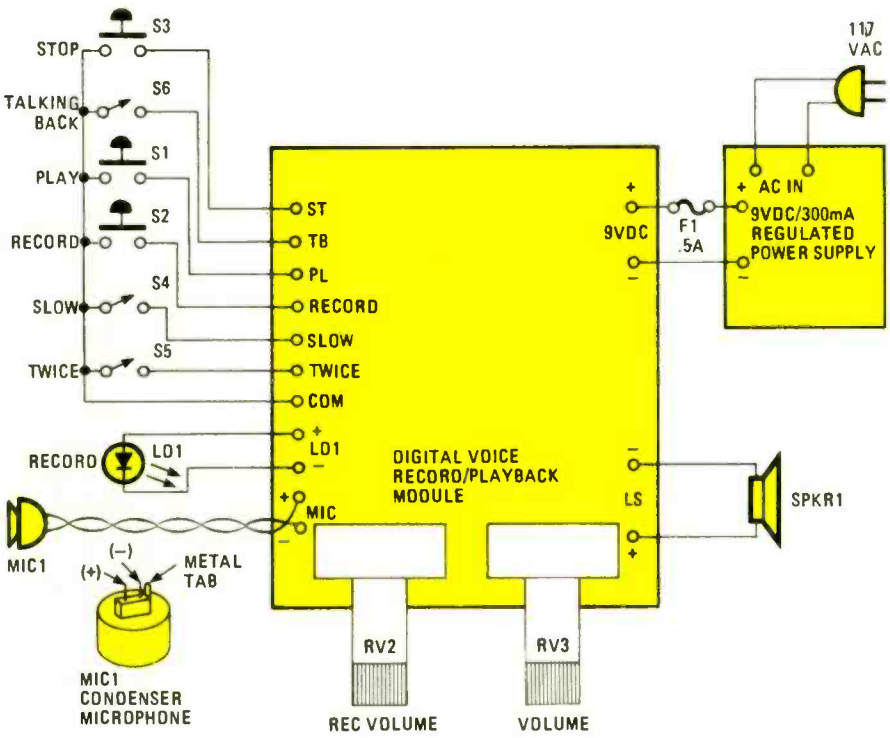


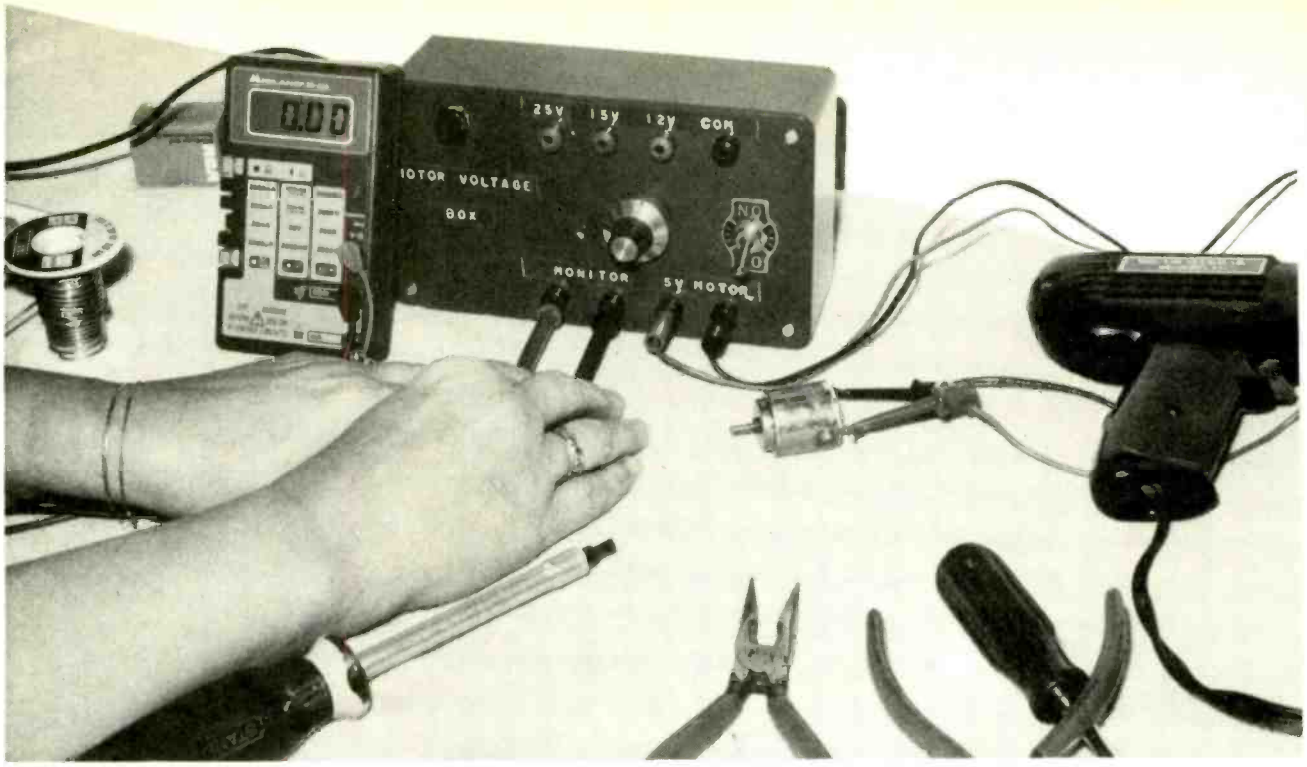
Fig. 2—After the printed-circuit board has been completely wired and inspected for cold-solder joints and solder bridges, the external circuit is connected. The microphone has three terminals; two of which (the negative terminal and the metal tab) are connected together by one lead and connected to terminal pin MIC−. The other microphone terminal connects to terminal pin MIC+.

Turn the three potentiometers to their mid-point position and turn on the supply. Watch the project carefully for signs of trouble (such as smoke or overheating components); if any turn up, remove power immediately.

Assuming all is okay, examine LD1; that LED should not be on. Press the RECORD button (S2) momentarily. The light-emitting diode will come on as long as the module is recording. Speak a few words into the microphone. When the LED goes off, the recording period has ended. Press the PLAY pushbutton switch (S1) and the loudspeaker will reproduce the words you have just spoken.

The recording sampling rate is preset using trimmer-potentiometer RV1. It is possible, however, to select a recording interval that is twice the preset maximum. That's done by jumpering between terminals labeled SLOW and COM on the circuit board. For maximum flexibility, we suggest setting RV1 for a normal maximum recording interval of 5 seconds, and installing a switch between the SLOW and COM terminals.

(Continued on page 100)



IDENTIFYING DEFECTIVE MOTORS

Pull those broken-down tape decks and defective turntables out of the closet because after reading this, you'll be a motor repairman

By Homer L. Davidson

AROUND AND AROUND IT GOES—DRIVING THE IDLER wheel, rotating the turntable, whirling the compact disc, or turning the drum of the VCR—and where the small motor stops, only the electronic technician or repairman knows. At times it may be erratic and intermittent in operation. Sometimes it never starts at all, due to an open winding or no drive voltage. And sometimes a motor problem has nothing at all to do with the motor. In this article, we'll show you how to find where a motor problem really lies, and what you can do about it.

Checking out motor problems is easy when you have the correct test instruments and know how. Replacing a defective motor is easy and can also be very satisfying. So let's check out some of those dead units that have been collecting dust.

Defective Motor Tests

One method of testing suspect motors is to use continuity checks. Of course continuity measurements may not indicate the motor has dry or frozen bearings, but it can tell you if you have an open winding. Also, the motor may have a shorted winding that will not be detected with continuity tests.

A more effective test you can perform is to measure the resistance of the windings. Low ohmmeter readings across the motor terminals will indicate if the motor windings are open or normal. Most small motors give a very-low ohmmeter reading. The small motor may have a resistance of under 20 ohms. If in doubt, check the schematic diagram.

Also, voltage measurements across the motor terminals may help you uncover a defective motor. Check the low-voltage supply source when a low or improper voltage is found at the motor terminals. Some small motors may have an open resistor in series with the winding (Fig. 1) indicated by lack of voltage across its terminals. Do not overlook a poor switch or wiring connection as the problem's source. You may assume the motor is defective when *correct* voltage is found at the motor terminals. However, zero volts at the motor tells you nothing, since it could indicate trouble with the supply circuit, shorted motor windings, or both.

An intermittent or erratic motor can be tested for by using an external DC voltage applied to the motor terminals. Sometimes rotating the motor shaft may start the motor, indicating intermittent operation. Replace the motor. In electric-motor control circuits, the external-voltage test may indicate a defective motor or control circuit. A variable or universal power-supply source is ideal in locating problems with motor-control IC's or transistors. Those low-voltage control circuits are found throughout the world of portable cassettes, compact-disc players, and camcorders (Fig. 2).

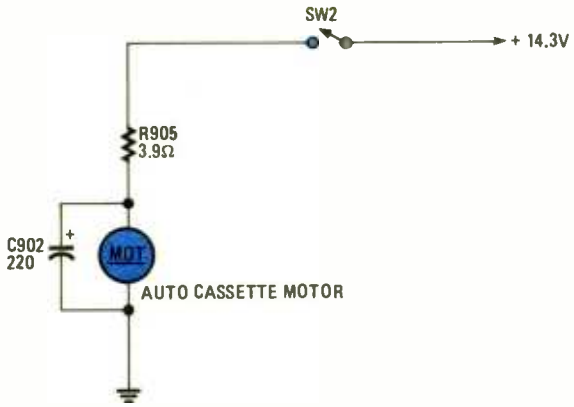


Fig. 1—Suspect a poor switch contact or open isolation resistor when no voltage is measured at the motor terminals in the audio cassette player.

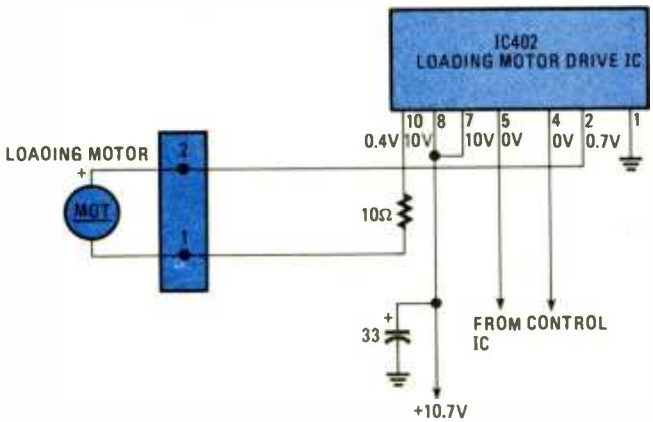


Fig. 2—Improper voltage found at the loading motor in a CD player may be caused by a defective voltage supply.

A Variable DC Source

A 0–5-volt variable-voltage source, in a cabinet with some fixed-voltage sources at 12, 15, and 25 volts could be used to check most DC motors. If you build the *Motor Voltage Box* shown in Fig. 3, the 12 and 25-volt sources may be used to check stereo 8-track, cassette, and auto cassette-player motors.

The 0–5-volt variable source can be used to test the very-low voltage motors found in the average compact disc (CD), camcorder, or portable cassette player. Note that you can reverse the polarity of the 0–5-volt source quickly with S1, a DPDT switch. Potentiometer R1 acts as a small variable-voltage control.

The circuit contains a small power transformer with bridge rectification. Four separate, 3-amp, silicon diodes are located in the bridge circuit. Capacitor, C1 filters out the DC ripple from the silicon rectifiers. Each voltage source has a separate fixed-voltage regulator, filter capacitor, and voltage-dropping resistor. The regulators are 1-watt types.

Etching the Board

All parts, except the transformer and the front-panel components, are mounted on a printed-circuit board like that shown in Fig. 4. Mount the components as shown in Fig. 5.

After etching has been completed, wash off the board, and clean it up with steel wool or a pocket knife. Inspect the wiring for breaks at the circle tie points and correct any. Tin the PC wiring with the soldering iron. Often, if the copper is not completely clean, the solder will not stick. Remove excess copper with a pocket knife. Drill out the component mounting holes with a small 1/16" drill bit.

Mounting the Parts

Mount all small components on the etched board. Keep all the hot parts, such as the regulators, about ½" above the board. Be sure to supply U1 and U2 with heat sinks.

Observe the polarity of the electrolytic capacitors and the IC regulators. Remember, the positive terminals of silicon diodes D2 and D4 connect to the positive terminal of the large filter capacitor C1.

Solder each connection with a low-wattage soldering iron. When done, double check each part for correct mounting and polarity.

After the PC-board wiring is complete, drill two 6-32 holes to mount T1. Make the holes to the right side of the plastic project box. They may be drilled, or made with the small tip of the soldering iron. Bolt the transformer in place. Solder the secondary's 18-volt leads to the PC-board solder pads marked

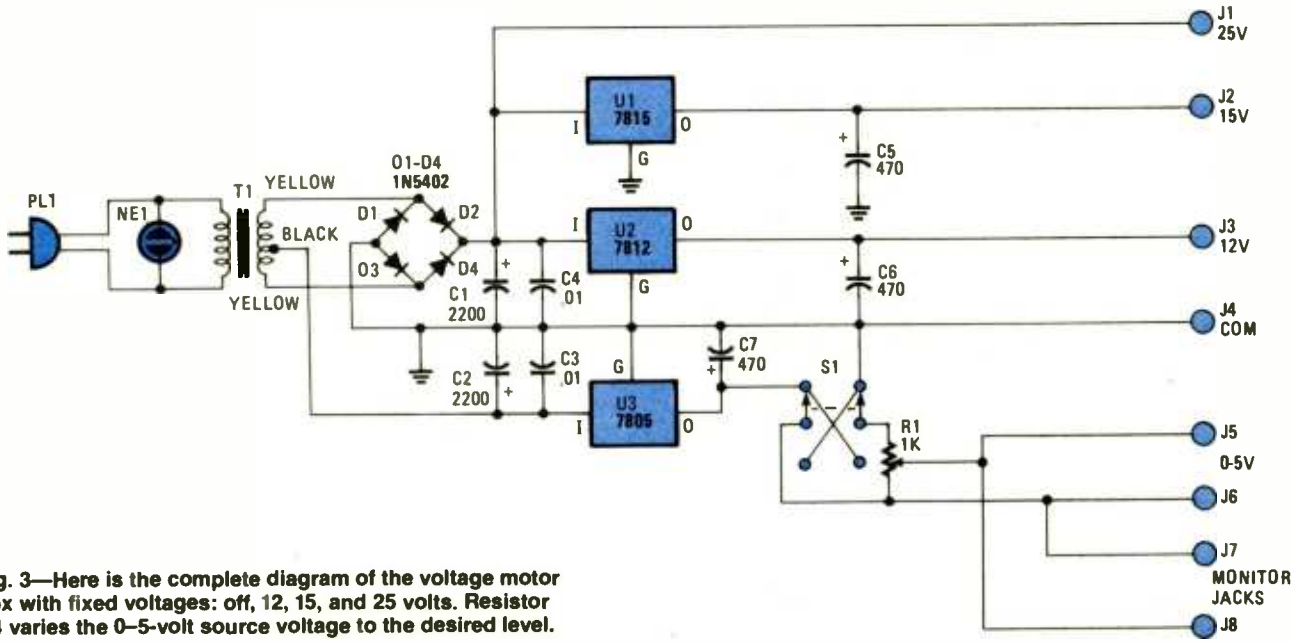


Fig. 3—Here is the complete diagram of the voltage motor box with fixed voltages: off, 12, 15, and 25 volts. Resistor R4 varies the 0–5-volt source voltage to the desired level.

PARTS LIST FOR THE MOTOR VOLTAGE BOX

SEMICONDUCTORS

U1—7815 15-volt regulator, integrated circuit
U2—7812 12-volt regulator, integrated circuit
U3—7805 5-volt regulator, integrated circuit
D1–D4—1N5402, 3-amp, 200-volt, silicon diode

CAPACITORS

C1, C2—2200-µF, 35WVDC electrolytic
C3, C4—.01-µF, 100WVDC ceramic
C5–C7—470-µF, 35WVDC electrolytic

ADDITIONAL PARTS AND MATERIALS

J1–J8—Banana jack
NE1—120-VAC neon lamp
R1—1000-ohm, 1- or 5-watt, wire-wound, potentiometer
S1—DPDT toggle switch
T1—18-volt secondary, CT, 2-amp, power transformer
Deluxe case, approximately 7.5 × 4.33 × 2.22, 3 heat sinks for TO220 cases, AC cord, flexible test leads, hookup wire, PC board, bolts and nuts, solder etc.

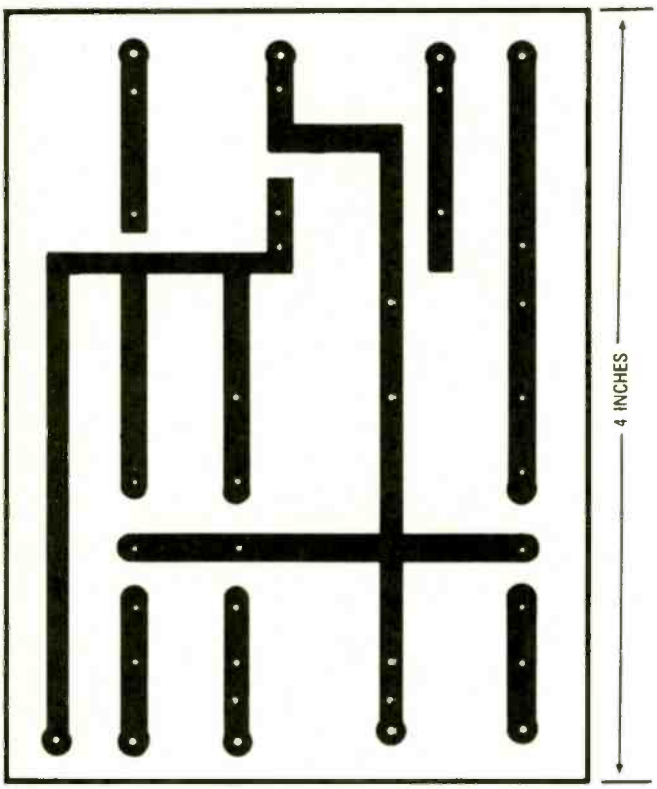


Fig. 4—This foil trace pattern, if used properly, will beautify the circuit layout of the box and simplify wiring.

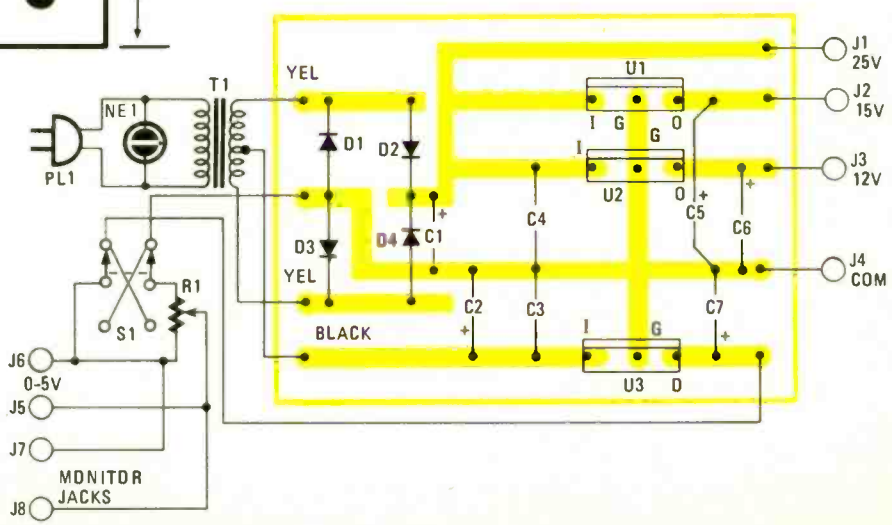


Fig. 5—Here is the parts placement layout of the etched circuit board. Cut the copper clad board from a large piece if you do not have the correct-size board.

YEL, and the center tap to the solder pad marked BLACK in Fig. 5. Do not mount the etched board until all wiring has been completed.

Wrap the wires around the body of a pencil to take up the slack. Tie a 4-inch length of hookup wire to each tie point that connects components on the front panel to the board. You may want to mark the voltage sources on top of the PC board to identify where the connecting wire goes.

Preparing the Top Panel

Drill all mounting holes through the top panel as shown in Fig. 6. Clean off any burrs with a pocket or hobby knife. The various fixed-voltage jacks (red) and the common jack (black) were located near the top of the front panel, while the 0–5-volt and monitor jacks (all are black) were positioned in the lower right.

Mount R4 in the 15/32-inch hole above the 0–5-volt and monitor-jack terminals. The two monitor banana jacks are provided so that the variable voltage can be monitored with a VOM or DMM without fuss.

Wiring it Up

Solder two 6-inch long hookup leads to the AC neon-light indicator, and tie them to the primary leads of the transformer and the AC-line cord. Tape up each set of leads separately. Tuck the taped leads near the base of the transformer. Next, connect and solder all the leads from R4 to S1 and their associated jacks. Tie the monitor jacks' wiring to the variable 0–5 volt DC jacks.

All wires to S1 should be tinned so they can be easily connected to the screw terminals. Check each voltage wire and solder them to their respective voltage terminals. If available, use a black hookup wire for the ground or common jack. If only one color of hookup wire is used, tie a knot in the ground wire for easy identification. Recheck each mounting wire from the board to the correct part on the front panel.

Testing the Box

After double checking all voltage connections and tie wires, the Motor Voltage Box is ready to be tested. Plug in the AC cord—the neon pilot light should light up at once. If not, check for the correct voltage at each IC input and output. Take voltage measurements at all of the fixed-voltage outputs. Feel each IC and heat sink to see if they are very hot. All board components should operate without undue heating.

Now, check out the 0–5-volt motor source. Measure the

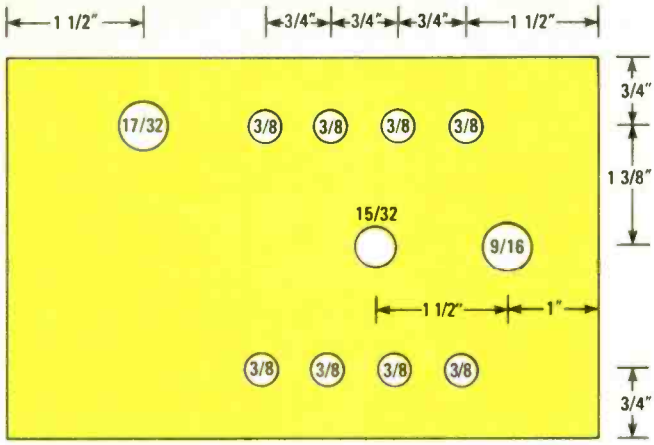
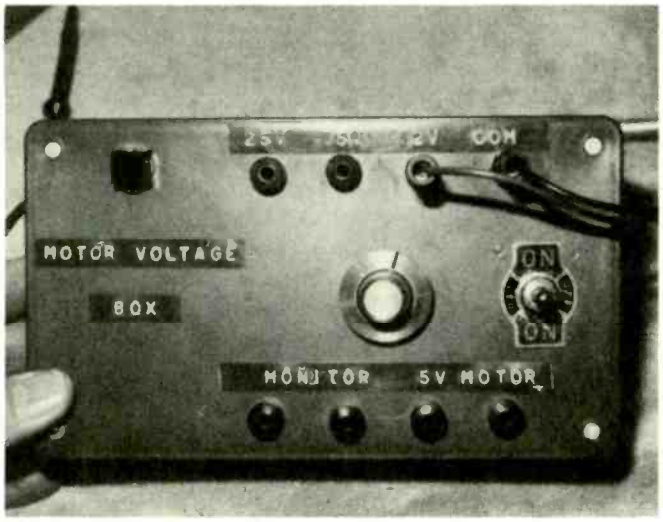


Fig. 6—Although mounting of the panel components is not critical, the fixed voltages are at the top, and the voltage monitor and variable-voltage jacks are at the bottom.



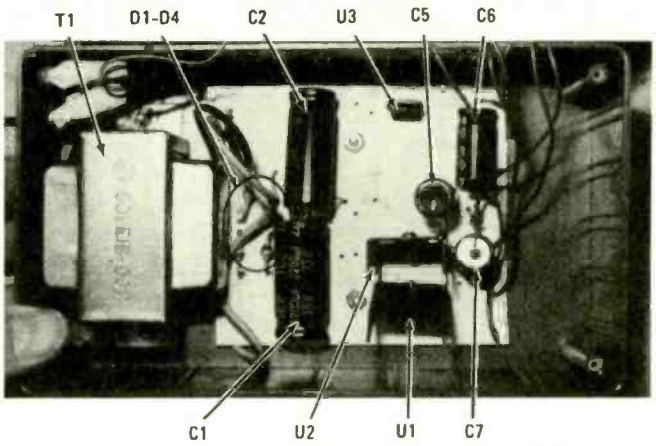
The constant voltage portion can test the various motors found in cassette, 8-track, and auto cassette players, while the 0–5 voltage source can check motors in portable cassettes, CD players, camcorders, and the like.

voltage at the voltage-monitor jacks. Slowly rotate R4 and note the change in output voltage. Flip S1 and the voltage polarity should reverse. Switch S1 reverses the voltage polarity for testing the small motors found in camcorders, cassette players, and compact-disc players. Remember, that voltage will drop when a motor loads the supply.

Checking Cassette Motors

Small motors come in different sizes and shapes. Most of the motors have two terminal wires, but some have three. In a three-wire motor hookup, their is a black wire used as a ground wire. Some motors of either type can change direction by having their voltage polarity reversed. Two small mounting screws usually hold the motor assembly to the metal chassis.

Check the continuity of the motor using the low-ohm range of an ohmmeter. A very-high or out of range reading may indicate bad brushes, an open field coil, or poor terminal connection(s). Measure the voltage across the two motor terminals. Go directly to the motor wire terminal connections for those tests since the common wire may not be grounded to the chassis. The motors may operate with from 3 to 18 volts DC. A portable cassette player's motor may operate on 3 to 6



All small parts are mounted on the PC board after drilling out the ⅛-inch holes in the etched wiring. Do not fasten the board to the bottom of the case until it's tested.

volts, while a boom box player's motor may operate with 6 to 12 volts. For a portable player, you can determine a motor's operating voltage by finding out the total battery voltage.

Suspect a defective motor when there is normal voltage at the motor terminals, but there's no rotation. Remove the small motor belt and rotate the motor pulley. The motor should be replaced if you can feel a pull while manually rotating the pulley or if the motor starts to spin. The intermittent or erratic motor may suddenly stop during operation, or just fail to start up.

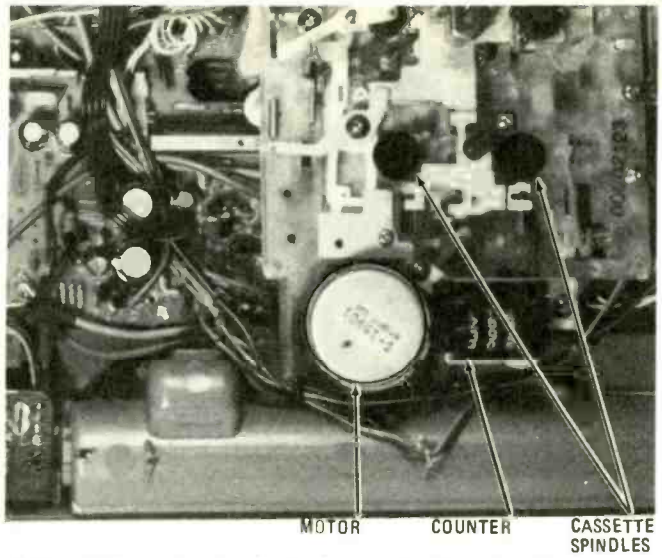
Intermittent rotation may be caused by a dry or frozen motor bearing. A dry bearing may make a squeaky noise as it rotates. Sometimes a drop of light oil on the bearings will provide extra hours of operation. Usually, with a frozen bearing the motor pulley can not be rotated. If the motor bearings are gummed up with old grease, wash out both end bearings with cleaning fluid.

When improper voltage is found at the motor terminals, check the motor-switch isolation resistor or power supply. Mark down the color of both motor terminal wires before removing. Apply the correct voltage to the motor using the Motor Voltage Box. Sometimes by applying an external voltage and watching for motor rotation, you can tell if the motor operates intermittently or slows down, or if it rotates at a constant speed. If the motor appears normal, check the control IC or processor for improper operating voltage.

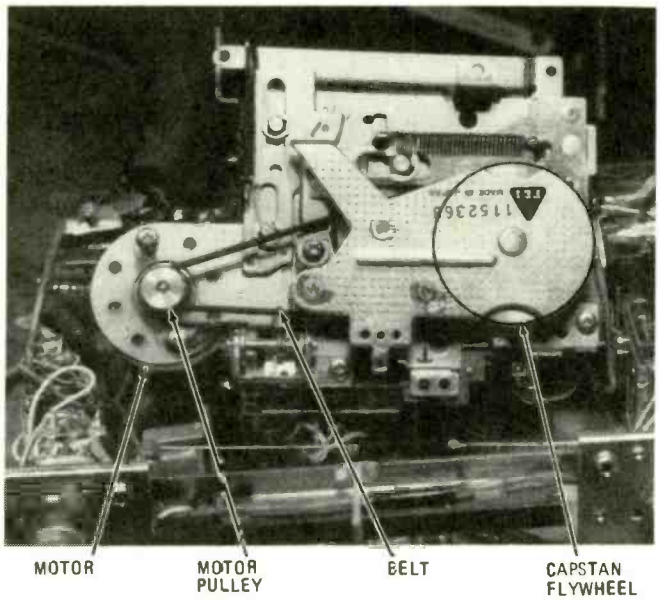
Testing Portable Decks

Portable cassette-player motors are often very small and operate on very-low voltage. Check the total battery voltage to determine the approximate operating voltage. Suspect a dirty leaf switch or shorted windings when no voltage is found at the motor terminals. Do not overlook a stretched or dirty motor belt on finding slow or erratic speeds.

Determine the condition of the small motor by connecting it to the 0–5-volt DC output of the Motor Voltage Box. Connect the positive lead of the box to the positive motor terminal. That will prevent the motor from rotating backwards and throwing out excess tape from the cassette. On any small low-voltage motor, always start with no voltage and slowly increase it. Slowly rotate R4 and notice the speed of the motor. Rotate the control until the correct voltage is applied and the music sounds normal. If the music sounds erratic and uneven, suspect a loose belt or dry capstan/flywheel assembly.



Although the motor terminal wires can be found out in the open for testing, the boom-box cassette player assembly must be removed before removing the motor-mounting screws.

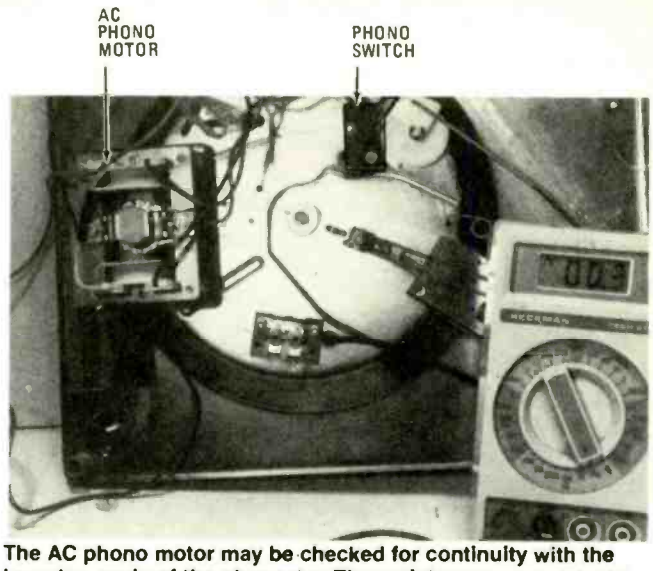


Remove the motor drive belt and rotate the motor pulley to see if the motor starts to rotate with correct voltage applied. Replace the cassette motor if it starts up after hand rotation or seems to pull as it is rotated.

Auto Cassette Motors

The auto cassette player may operate directly from the car battery or a voltage-regulator circuit. The voltage measured at the motor terminals may vary from 12 to 14 volts. If there's no voltage to be measured at the motor terminals, suspect a poor switch contact or open isolation resistor. When you see an improper voltage at the motor, suspect the voltage-control circuitry.

Rotate the motor pulley and notice the magnetic pull of the armature. Doublecheck the motor by removing the motor terminals and connecting them to the 12- or 15-volt DC output of the box. If the motor takes off, suspect a defective motor-control circuit. Let the motor run for several minutes to determine if it's intermittent. Grasp the motor pulley and stop it momentarily. Notice if the motor speeds up at once. Replace the motor if it will not start up or if it is intermittent.



The AC phono motor may be checked for continuity with the low-ohm scale of the ohmmeter. The resistance measurement may be quite low so be sure to set the scale to low.

Disc or Camcorder Motors

The really small motors found in CD players or camcorders may have several leads connected to them. Some of the motors are brushless types. In most CD players, the loading, disc, and carriage motors have only two leads, while in other players the disc and carriage motors may have more. Likewise, the focus, zoom, and iris motors in camcorders may have two motor leads. Sometimes three separate leads are fed to the camcorder motor with the third (usually black) wire grounding the motor assembly.

Be careful when testing or applying external voltage to small motors. Low-range resistance measurements may be made and external voltage may be applied to camcorder motors with two leads.

Remember, some of the motors are designed to operate with a 0.5 volt to 1 volt DC. Start R4 at zero and monitor the applied voltage. If the motor does not turn, flip the DPDT switch. Most of the motors operate in either direction while in operation, except the spindle or disc motor found in CD players. Suspect a defective motor, or a dry rail or gear assembly when the rotation is slow. **Do not** apply external voltage to a small motor with more than three terminals.

Phono Motor Tests

Most of the motors found in phonographs operate from the power line, except for small battery-powered record players. Check the continuity with the low-ohm range of your ohmmeter. Measure the AC voltage across the motor terminals with the player turned on. If the line voltage is found at the motor connections, with normal continuity, suspect a gummed-up motor or open windings.

Spin the motor pulley with your fingers. If the motor starts to rotate after giving it a spin, remove and wash out the bearing with cleaning fluid. Sometimes, if the phonograph is left on for extended periods of time, the motor bearings may get hot and freeze up. A slow phono motor may result from gummed-up bearings, while noisy rotation indicates a dry bearing. A couple of drops of light oil may clear up a slow and squeaky bearing.

Finding where motor-related problems lie is a snap, once you know how. Now that you've read this article, you do! ■

E-Z MATH

NETWORK ANALYSIS & THEVENIN'S THEOREM

By Louis E. Frenzel

When you've got a circuit schematic with enough interconnections to make a traffic planner ill, how do you analyze it without getting ill? Network analysis!

MOST OF THE MATHEMATICAL OPERATIONS USED IN electronics are performed for one of two purposes. First, the math helps to analyze a circuit. In analyzing a circuit, you find out not only how it works, but what the various current, voltage, and impedance levels are. Circuit analysis allows you to experiment with the circuit mathematically to determine how conditions change if one or more parameters are varied.

The second reason for this type of math is circuit design. Whenever you wish to create a new circuit to perform a specific function, you must be able to specify what you want, then work backwards to synthesize the circuit that will give it to you. The math lets you do that on paper.

Circuit analysis in electronics is really not all that difficult. Typically, a great deal of it can be done with the basic electrical laws you no-doubt learned somewhere along the line. Specifically, I am speaking of Ohm's law and Kirchhoff's laws. Both are simple mathematically and very easy to understand and apply. (See the sidebar entitled "Ohm's and Kirchhoff's Laws" for a quickie review of those important electronics laws.)

When the circuits are essentially simple series and parallel circuits, all you need is Ohm's and Kirchhoff's laws to analyze and solve them completely. But as the circuits get more complex, the laws, while they still apply, are more difficult to use. In some cases complex circuits defy analysis or design. That's where special circuit theorems come into play. Over the years, many different techniques have been developed for analyzing and designing electronic circuits. The theorems are really not any more difficult to understand or apply than Ohm's or Kirchhoff's laws, but they have *high falutin'* sounding names and often intimidate people. In reality, they are nothing more than tricks and shortcuts that help you speed up and simplify the analysis and design of circuits.

In this article, we'll cover the popular and widely used Thevenin's theorem.

Voltage Sources

Almost any electronic circuit can be represented by the simple equivalent circuits shown in Fig. 1. The circuits consist of a voltage source with an internal impedance and some type of load. In Fig. 1A, the source is a battery with a voltage of V_S and its internal resistance R_S connected to a resistive load R_L. A simple example might be a flashlight where the battery represents some 1.5-volt D cells, and the load represents the light bulb. Another example might be where the battery in Fig. 1A represents a DC electronic power supply with its internal resistance R_S while the load represents one or more electronic circuits.

In Fig. 1B, the voltage source is an AC generator with its internal impedance connected to a load. That might represent any number of circuits. For example, the AC generator might represent the output of an amplifier with its internal impedance R_S, while the load R_L may represent a speaker. Another example is that the voltage source might represent the class-C output amplifier of a CB transmitter with its output impedance connected to a 50-ohm load which represents an antenna. Those are only a few examples, but you get the idea. Almost any electronic circuit can be simplified until it is represented by an equivalent circuit similar to those shown in Fig. 1. In some cases, you will hear the internal resistance

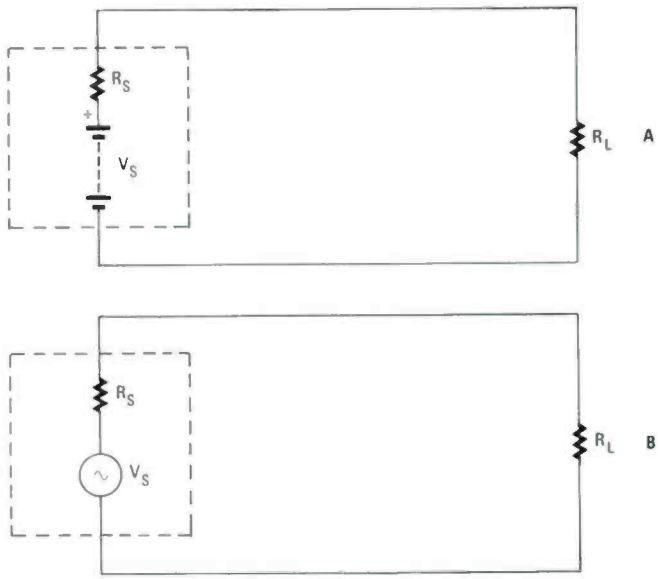


Fig. 1—These are the simplest ways of representing a current or voltage source. They are known as Thevenin equivalents and they greatly simplify circuit analysis.

Ohm's and Kirchhoff's Laws

Ohm's law is a mathematical statement of the relationship between the current, voltage and resistance (or impedance) in a circuit. It states:

"The current is directly proportional to the applied voltage and inversely proportional to the resistance (or impedance)."

In mathematical form, Ohm's law is expressed as:

$$I = V/R$$

where I is the current in amperes, V is the voltage in volts, and R is the resistance in ohms. For example, if a 20 ohm resistor is connected to a 12-volt battery, the current is:

$$I = 12/20 = .6 \text{ ampere}$$

Using algebra, you can rearrange the above formula to calculate the voltage or resistance:

$$V = IR$$
$$R = V/I$$

Kirchhoff's Laws

There are two basic Kirchhoff's laws, one for series circuits, the other for parallel circuits. Kirchhoff's voltage law for series circuits states:

"The sum of the voltage drops across components in a series circuit is equal to the source voltage." In Fig. A, that can be written mathematically as:

$$V_S = V_1 + V_2 + V_3$$

where V_S is the source or applied voltage and V_1, V_2 and V_3 are the voltages across R1, R2, and R3. In Fig. A, the source voltage is:

$$8 + 6.5 + 2.3 = 8 \text{ volts}$$

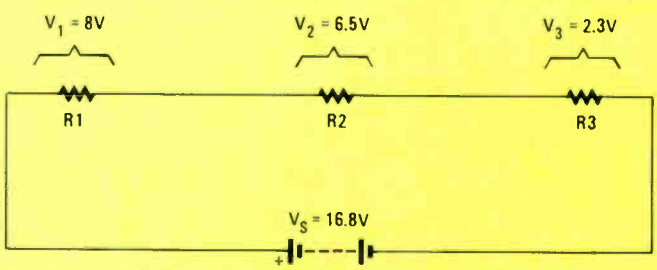


Fig. A—Kirchhoff's voltage law for series circuits simply states that the input voltage must equal the sum of the voltage drops. That means no voltage "leaks" out.

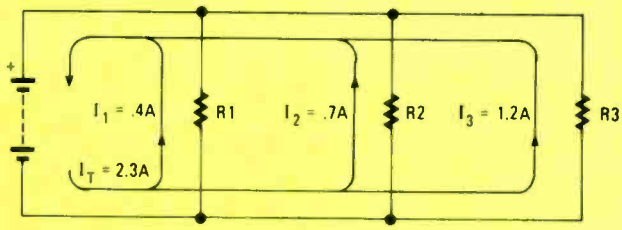


Fig. B—Kirchhoff's current law for parallel circuits simply states that the source current must equal the sum of the current through all branches. The electrons must remain in the circuit and return to the current source.

You can also rearrange the formula to solve for one of the resistor voltages if the source voltage and the other component voltages are known. For example:

$$V_1 = V_S - V_2 - V_3$$

Kirchhoff's current law for parallel circuits states:

"The sum of the currents in the branches of a parallel circuit is equal to the total line current drawn from the source."

In Fig. B, that is expressed as:

$$I_T = I_1 + I_2 + I_3$$

where I_T is the total line current supplied by the battery and I_1, I_2 and I_3 are the individual branch currents in the resistors. In that case, the total line current is:

$$I_T = .4 + .7 + 1.2 = 2.3 \text{ A}$$

You can also rearrange the formula to solve for any branch current. To find I_2 for example:

$$I_2 = I_T - I_1 - I_3$$
$$U_2 = 2.3 - .4 - 1.2 = .7 \text{ A}.$$

The three laws are used in the solution to almost any circuit problem. Commit them to memory and apply them as needed. ■

referred to as the *output impedance* of the voltage source.

The whole idea of most circuit theorems is to attempt to simplify the larger, more-complex electronic circuits and convert them so they can be represented by a simple circuit like those given in Fig. 1. In most cases, all circuits can be reduced to the equivalent of a voltage source in series with its internal resistance and the load. That is, in fact, the whole purpose of Thevenin's theorem. By using Thevenin's theorem along with the usual Ohm's and Kirchhoff's laws, you can easily reduce most circuits into a Thevenin's equivalent which is essentially a voltage source in series with its internal resistance and a load. But before we talk in detail about the Thevenin's theorem process, let's get a little-more familiar with voltage sources.

In electronic-circuit design, engineers strive to achieve what is known as an ideal voltage source. An ideal voltage source is some component or circuit that supplies a fixed output voltage to a load. That voltage, of course, will cause current to flow through the load and in that way produce some useful end effect. The problem is most voltage sources are not ideal. They will not provide a constant output voltage for all load values. Changing the load resistance invariably will change the amount of voltage supplied by the voltage source. The reason for the change is that all practical voltage sources have a built-in internal resistance or output impedance. Take a battery for example. It is about as close to a perfect voltage source as you can find in practice. You can almost connect any value of load resistance to a typical D cell and its output voltage will remain at approximately 1.5 volts. The reason for that is that the battery has an extremely low internal resistance (output impedance). It is usually so low, compared to the load resistance, that it is negligible, and so it is considered to be zero in most cases. But as you make the load resistance smaller, the internal resistance becomes a larger percentage of the total circuit resistance. It is at that point that decreasing the load resistance causes the output voltage to drop considerably. Let's take a look at that phenomenon in a little greater detail.

Figure 2A shows a voltage source V_S with its internal resistance R_S. With no load connected to the battery, no current will flow. With no current flowing through the internal resistance, no voltage drop will be produced across it. For that reason, the voltage at terminals A and B will simply be the natural voltage produced by the battery. That is known as the open-circuit voltage, which is just V_S here.

Now, take a look at Fig. 2B. A load, R_L, is now connected to the voltage source. That, of course, causes current to flow through the load and the internal resistance. The current through the internal battery resistance will produce a voltage drop across it, denoted V_i. The voltage drop, when added to the load voltage, will equal V_S just as Kirchhoff's law says. The voltage across the internal resistance will, of course, take away from the voltage that appears across the load. The best way to see that is to take an example.

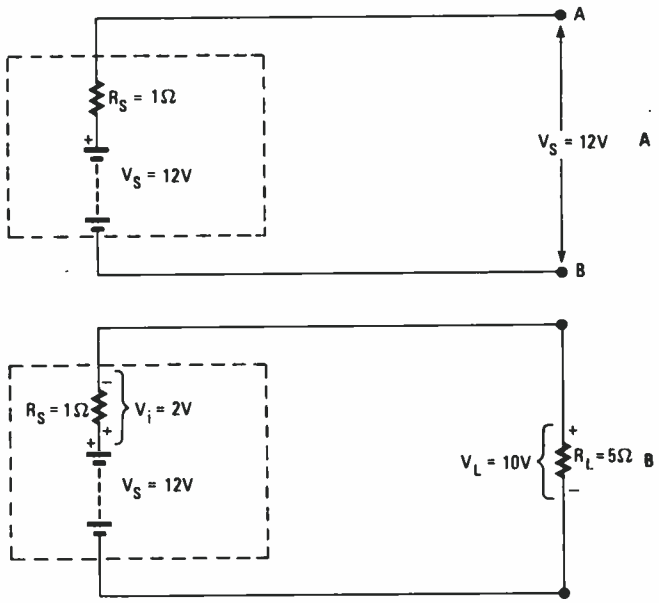


Fig. 2—In an unloaded state (A), the voltage source can be treated as though its internal resistance does not exist. When a load is applied (B), the resistance becomes noticeable.

Suppose that we have a 12-volt battery with an internal impedance of 1 ohm. Then suppose we connect a 5-ohm load to the circuit. We know that the total circuit resistance R_T is the sum of the individual resistors, in this case, the 5-ohm load resistance plus the 1-ohm internal resistance for a total of 6 ohms:

$$R_T = R_S + R_L = 1 + 5 = 6 \text{ ohms}$$

We can now use Ohm's law to find out what the current is:

$$I = V/R = 12/6 = 2 \text{ A.}$$

We know that the total circuit current now is 2 amperes. To find out what the voltage across the load is, we again use Ohm's law. Remember that the voltage is simply the current multiplied by the resistance. The load voltage is:

$$V_L = I \times R_L = 2(5) = 10 \text{ volts}$$

Well, you can see that the voltage across the load is not the entire 12 volts generated by the battery. All we are getting is 10 volts across the load. Where is the other 2 volts? The answer is, it is being dropped across the battery's internal resistance. Looking at Fig. 2B, you can see that as current flows through the internal resistance, it produces a voltage drop of:

$$1 \text{ volt} \times 2 \text{ amperes} = 2 \text{ volts.}$$

The polarity of that voltage drop is as shown in the figure. The polarity is opposite to that of the battery polarity and so the two voltages oppose one another. That's why we say that the 2 volts across the internal resistance takes away from the battery voltage leaving only 10 volts across terminals A and B, which are the actual battery terminals. That is why you see only 10 volts across the load. All that makes sense because Kirchhoff's law tells us that the sum of the voltage drops is:

$$V_S = V_i + V_L = 2 + 10 = 12 \text{ volts}$$

Now you can see why an ideal voltage source is so desirable. With zero internal resistance, all of the voltage generated is applied across the load. Since perfect voltage sources can't be obtained in practice, then the objective is simply to keep the internal resistance as low as possible. That is always the basic design objective of most engineers. The lower the internal resistance compared to the load resistance, the greater the amount of voltage that appears across the load.

One way to analyze a voltage source with its load is to look at the internal resistance R_i and the load resistance R_L as a voltage divider. It can be more-easily seen if we redraw the circuit as shown in Fig. 3. A voltage divider is simply two or more resistors that are used to develop an output voltage somewhat lower than the input voltage. Normally, we design voltage dividers by choosing two resistor values that will give a desired output voltage for a given input voltage. The basic formula used for figuring the output voltage of a voltage divider given the resistor values and the source voltage is:

$$V_O = V_S R_L/(R_S + R_L)$$

Here, V_O is the output voltage across the load, V_S is the open circuit source voltage, R_L is the load resistance, and R_S is the internal resistance of the voltage source. As an example of the use of the formula, let's use the 12-volt battery we assumed before, but this time assume it has an internal impedance of 0.1 ohm instead of 1 ohm. The load resistance is still 5 ohms. The voltage across the load in that case then would be:

$$V_O = 12(5/(5 + 0.1)) = 12(.98) = 11.76 \text{ volts}$$

Here you can see that when the internal resistance is only a tenth of an ohm instead of 1 ohm, the output voltage is 11.76 volts, or very much closer to the source voltage than the 10 volts produced with an internal impedance of 1 ohm. Now you can see why it is desirable to keep the internal impedance low.

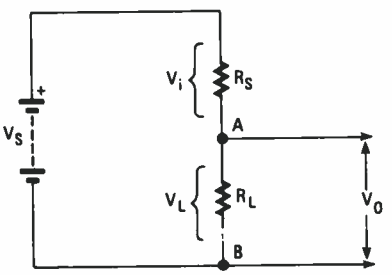


Fig. 3—The source's internal resistance and the external load form a voltage divider making the output voltage of the source easy to determine with voltage divider relationships.

One of the main problems in dealing with voltage sources is that it is often very difficult to determine the internal impedance of a source. For example, how do you know what the internal resistance of a battery is? We know that it is extremely low when the battery is good and, in most cases, it can be ignored or assumed to be zero. But as the battery discharges, the internal resistance increases. That's why when a battery goes bad, its output voltage drops to a very low level. When you connect a load to it, the current that flows produces a large internal voltage drop, leaving less voltage at the battery terminals for the external circuit.

Unfortunately, you just can't get an ohmmeter and connect it to a battery and expect to measure the internal resistance. Neither can you do that on any other kind of voltage source nor AC generator. Yet it is important to be able to determine what that internal impedance is so that you can perform the circuit analysis. Well, there is a way to determine the internal impedance, although not by direct measurement. Let's take an example, but this time let's use an AC-voltage source.

Refer to Fig. 4. There is an AC generator with an internal impedance of R_S. It might be a signal generator or function generator used for bench testing. Let's assume for a moment that we don't know what the internal impedance is. Through a series of measurements and calculations though, we can determine the output-impedance value. To do that, use the following procedure:

1. Measure the open-circuit generator voltage. With no load on the circuit, connect a multimeter or oscilloscope across the generator output terminals A and B. Measure the output voltage. That is the real generator source voltage V_S as no current is flowing through the internal resistance R_S. Assume you measure 6 volts.

2. Next, connect a load R_L to generator terminals A and B. In general, it is best to connect a load resistance that is close to, but somewhat higher than, the internal impedance. Since you don't know what the internal impedance is, it is difficult to estimate what kind of load resistance to connect. Although in some cases you may have a feel for the general range of the output impedance. If you do, then assume a load resistance that is somewhat higher. In that case, let's just say that you guessed the output impedance is about 50 ohms, but you don't really know for sure. Say you picked a 100 ohm load resistance.

3. With the load connected, measure the load voltage. Let's say you measured 4 volts.

4. You now have enough information to calculate the circuit current. You can determine the current with Ohm's law by simply dividing the load voltage by the load resistance:

$$I = V_L/R_L = 4/100 = .04A.$$

5. Now you are ready to actually calculate the internal generator impedance. You do that with a combination of both Kirchhoff's and Ohm's laws. You know that the generator produces 6 volts output under open-circuit condition. With the load connected, you get 4 volts at the output terminals. From Kirchhoff's law then, you know that the voltage dropped across the internal impedance V_i is the difference between those two voltages:

$$V_S + V_i + V_L$$
$$V_i = V_S - V_L$$
$$V_i = 6 - 4 = 2 \text{ volts}$$

Knowing that 2 volts is dropped across the internal resistance and knowing that the current flowing through it is .04 amperes, the source impedance can be calculated as follows:

$$R_S = 2/.04 = 50 \text{ ohms}$$

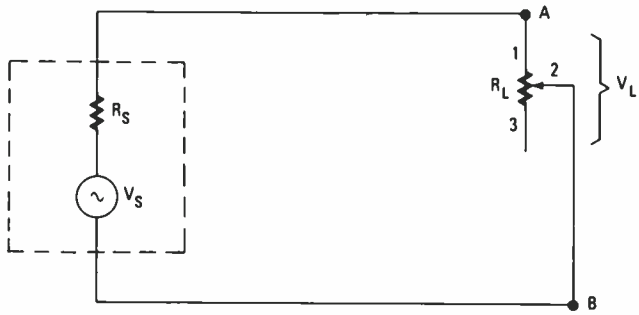


Fig. 4—The internal impedance of a source can be determined by making a few measurements and using Ohms law.

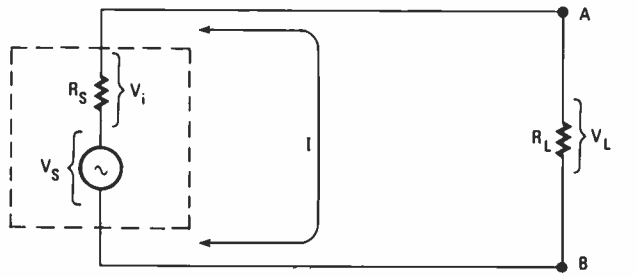


Fig. 5—A quick technique for measuring the output impedance of any device can be performed using a potentiometer, and by taking two measurements.

Another method of measuring the internal resistance or output impedance of a voltage source is to use the technique illustrated in Fig. 5. It is called the half-voltage method. Use the procedure described below:

1. Estimate the value of the output impedance, R_S. Let's assume that you guess that R_S is near 600 ohms.

2. Select a variable resistor whose value is larger than the estimated value. For example, you may choose a potentiometer with a value of 1000 ohms. In general, you may want to make the resistance larger just in case the actual output impedance is larger. You might choose a 2.5K- or 5,000-ohm potentiometer for the application. That is the load resistance, R_L.

3. Measure the open circuit or no-load output voltage of the generator at terminals A and B as you did before and record the value as V_S. Assume that it is 8 volts.

4. Connect the potentiometer across the voltage source as a variable load resistor R_L as Fig. 5 shows. Connect a voltmeter or oscilloscope across the load resistance. Vary the load resistance until the output voltage V_L drops to one-half of the open-circuit value. In that case, you would adjust the potentiometer until the load voltage was 4 volts.

5. Without disturbing the potentiometer, disconnect it from the voltage source. Then, using an ohmmeter, measure the resistance between the arm of the pot and the end you connected to the circuit, in this case, terminals 1 and 2. The resistance value will be equal to the output resistance of the circuit, or:

$$R_S = R_L.$$

Assume that you measured a value of 650 ohms across the potentiometer. You would know then that the output impedance was 650 ohms.

Why does the technique work? It works because you are adjusting the load resistance to half the output voltage, and so you are dividing the output voltage into two equal parts, one part of which is dropped across the load itself, which you are measuring, while the other half is dropped across the internal resistance. If the load voltage and internal-resistance voltages are equal, then their resistance values should also be equal because the current flowing in both is the same. That is why when the output voltage is dropped to one half, the load resistance equals the internal resistance.

Remember those important techniques when working with voltage sources. They will help you determine internal impedances and help you to calculate them.

Now we are ready to take a look at Thevenin's theorem itself.

Thevenin's Theorem

Thevenin's theorem describes a process of converting any complex electrical or electronic circuit into a simple equivalent circuit consisting of a single voltage source in series with an internal impedance. In other words, a complex electronic circuit represented by the box in Fig. 6A would be converted into a DC or AC voltage source as illustrated in Fig. 6B or 6C. The equivalent circuits consist of an equivalent or Thevenin's voltage source designated V_{th} in series with an equivalent internal resistance designated the Thevenin's resistance or R_{th}. The mathematical process of converting the larger, more complex circuit into its Thevenin's equivalent is called "Theveninizing" a circuit. The mathematical process of Thevenin's theorem takes the voltages and resistances of the complex electronic circuit and uses them to calculate V_{th} and R_{th}. That's what we want to show you how to do here.

Let's start with a relatively simple circuit, but one that is widely used and that Thevenin's theorem makes much easier to analyze. Figure 7 shows a DC-voltage source connected to a simple two-resistor voltage divider. A load resistance R_L is connected across the voltage-divider output. Typically the problem is to determine the output voltage across terminals A and B, or V_{AB}, for different values of load resistance. Of course, you can use standard circuit-analysis techniques for computing parallel- and series-resistance values, then use Ohm's and Kirchhoff's laws to compute the value for the output voltage for each load resistance. That is a rather time-consuming process. A much easier approach is to simply Theveninize the circuit, coming up with a simple voltage-source equivalent to which the load is connected. With such an arrangement, the output voltage for various values of load resistance can be more quickly and easily obtained.

To Theveninize a circuit, the first step is to remove the load resistance as shown in Fig. 8A. Then, use standard Ohm's- and Kirchhoff's-law procedures to compute the voltage that appears across A and B without the load. That is called the

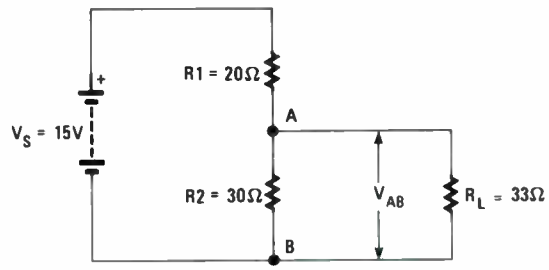


Fig. 7—Of course, you can use techniques for computing parallel and series resistance values, and use Ohm's law to compute the output voltage for each load resistance. A much easier approach is to simply Theveninize the circuit.

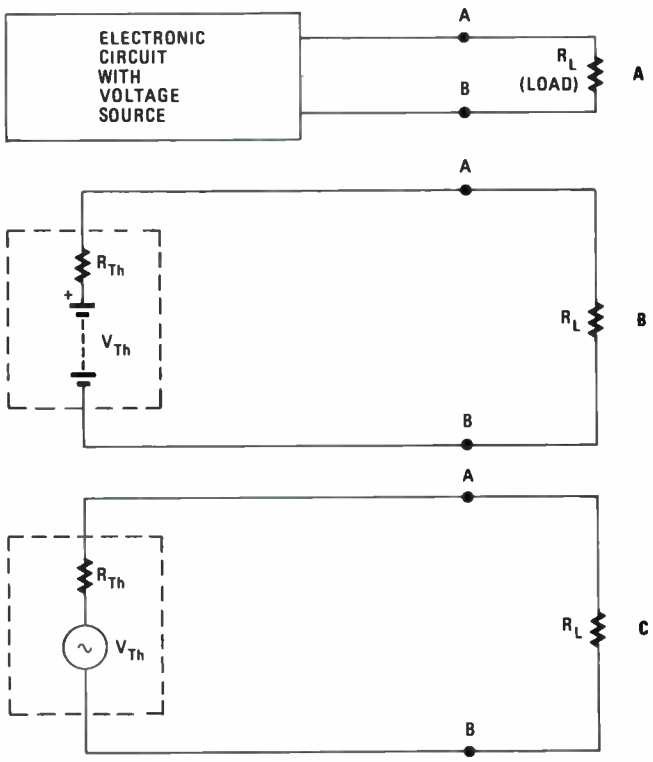


Fig. 6—Any complete circuit (A) can be replaced by its DC Thevenin (B) or AC Thevenin equivalent for analysis.

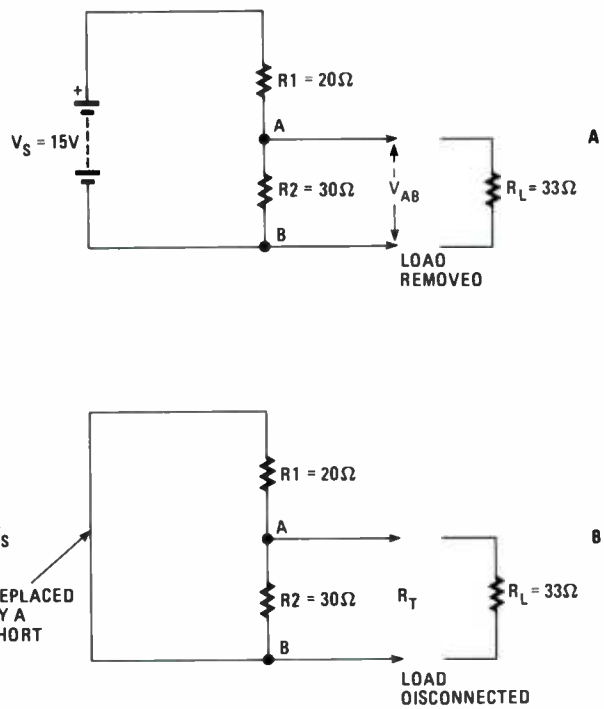


Fig. 8—The first step in Theveninizing a circuit is to analyze the circuit without the load (A) to find the voltage. Next you must short the voltage source(s) to determine the thevenin equivalent impedance. Finally you replace the load, but now connected to the equivalent.

Thevenin's-equivalent voltage, V_{th}:

$$V_{th} = V_{AB}$$

To compute the Thevenin's-equivalent voltage between points A and B, you can use the simple voltage-divider formula given earlier. We can express that as follows:

$$V_{AB} = V_S R1/(R1 + R2)$$

Using the values in Fig. 8, the Thevenin's-equivalent voltage then is:

$$V_{th} = 15(30)/(20 + 30) = 15(30/50) = 15(.6) = 9 \text{ volts}$$

The equivalent voltage source for the circuit then is a 9-volt battery.

Next, we need to compute the Thevenin's-equivalent resistance. Again, that is done by assuming that the load resistance is disconnected. It also assumes that the voltage source is replaced by a short circuit. That condition is illustrated in Fig. 8B. With the voltage source shorted, you simply calculate the total equivalent resistance between terminals A and B. In this case, the 20- and 30-ohm resistors are simply in parallel with one another, and so the equivalent resistance can be computed by using the standard parallel-resistance formula. The total resistance is:

$$R_T = R1R2/(R1 + R2) =$$
$$20(30)/(20 + 30) = 600/50 = 12 \text{ ohms}$$

The total resistance therefore, is the Thevenin's-equivalent resistance R_{th}:

$$R_{th} = R_T$$

We can now draw the complete Thevenin's equivalent, which is illustrated in Fig. 9. It is simply a 9-volt battery in series with a 12-ohm resistor. The load is reconnected to terminals A and B. Now using Ohm's and Kirchhoff's laws for additional calculations, the equivalent circuit, which is easier to work with, will produce exactly the same output voltage for varying load values as the original circuit. The load voltage, V_L, between A and B is found as follows:

First, calculate the total circuit resistance, R_T:

$$R_T = R_{th} + R_L$$
$$R_T = 12 + 33 = 45 \text{ ohms}$$

Next, find the current, I:

$$I = V_{th}/R_T = 9/45 = .2 \text{ A.}$$

The load voltage, V_L, then is:

$$V_L = I \times R_L = .2(33) = 6.6 \text{ V.}$$

Now, let's take a somewhat more complex circuit. Refer to Fig. 10A. Again we wish to compute the Thevenin's-equivalent voltage and resistance. As usual, we begin by removing the load resistor. See Fig. 10B. Then we calculate the output voltage between terminals A and B. Note that we are using an AC generator. That is just to remind you that Thevenin's theorem works for both AC and DC circuits. The generator in the circuit supplies 6 volts to the network made up of resistors R1, R2, and R3. Note that R1 and R2 form a voltage divider across the generator. Since the two values of resistance are equal, then the source voltage will simply divide equally across them. That means that there will be 3 volts dropped across R1 and 3 volts dropped across R2. The voltage across R2 is the output voltage applied to terminals A and B. The voltage is, of course, applied through resistor R3. Since there

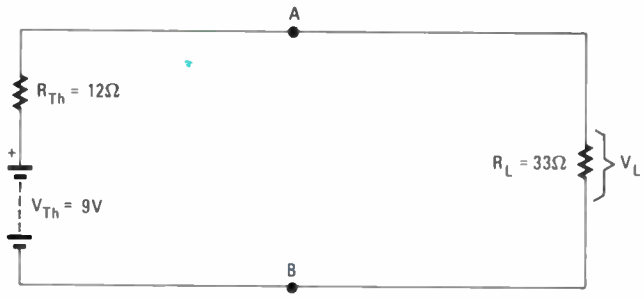


Fig. 9—This is the complete Thevenin's equivalent of Fig. 7. The load is reconnected to terminals A and B. Using Ohm's and Kirchhoff's laws the equivalent circuit will produce exactly the same output voltage values.

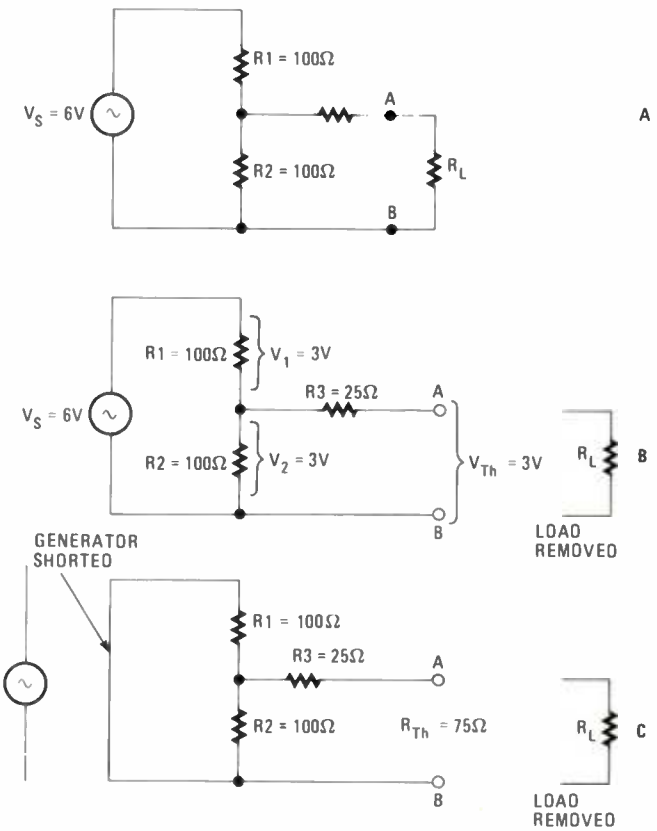


Fig. 10—We wish to compute the Thevenin's equivalent voltage and resistance of the circuit in A. Begin by removing the load (B) and calculating the output voltage. Note that we are using an AC generator.

is no load connected to terminals A and B, then no current flows through R3, and so there is no voltage across it. So the voltage across terminals A and B is simply the voltage across R2, or 3 volts. That is the Thevenin's-equivalent voltage, V_{th}.

Next, compute the Thevenin's-equivalent resistance. That is done by shorting the generator and computing the total value of resistance between terminals A and B. The equivalent circuit is shown in Fig. 10C. First note that R1 and R2 are simply put in parallel. Putting two equal values of resistance in parallel gives a total resistance value of one-half the value of one of the resistors. The total equivalent resistance of R1 and R2 in parallel then is 100/2 = 50 ohms. The total resistance between A and B then is simply 50 ohms added to the value of R3 of 25 ohms, for a total of 75 ohms. That is the Thevenin's-equivalent resistance, R_{th}. Now you can connect

various values of load resistance and compute the output voltage for each using Ohm's and Kirchhoff's laws.

Practice Problem

1. Now it's time for you to try it yourself. Refer to Fig. 11. Calculate the Thevenin's equivalent voltage and resistance.

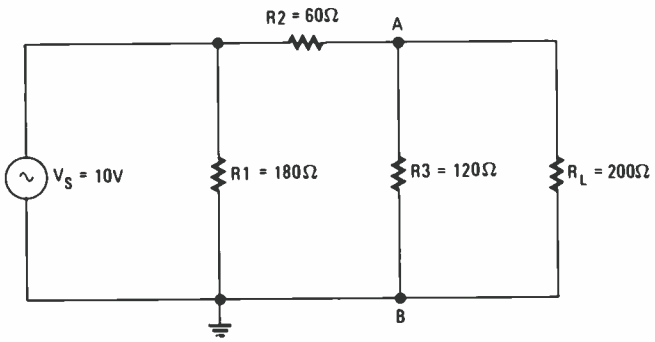


Fig. 11—When trying out this problem, remember these steps: remove the load; compute the Thevenin voltage; compute the Thevenin resistance; connect the load to the equivalent circuit to observe its behavior.

You really appreciate the power and convenience of a procedure such as Thevenin's theorem when you encounter a rather complex circuit to analyze. A good example is the bridge circuit shown in Fig. 12. All bridge circuits, whether they are made with resistors or a combination of resistors, capacitors, inductors, or transistors, have four arms. In general, most bridge circuits are balanced. In other words, the relationship between the resistances and/or impedances of the various arms is as follows:

$$R1/R2 = R3/R4$$

So, when the ratios of the resistances are equal, the bridge is said to be balanced. If that is true, the voltage at A is equal to the voltage at B with respect to ground and no current flows through the load resistance.

Changing one of the arm values will cause the bridge to become unbalanced. Depending upon the nature of the change, that will cause current to flow through the load resistance from A to B or from B to A, depending on the conditions. Our job is to calculate the current in R_L given the values in Fig. 12.

Bridge circuits in general are a pain in the neck to analyze. Particularly if you wish to determine the amount of current through the load for different values of load resistance. The computations are complex, messy, and time consuming. The chances for making an error are also high. But then, along comes Thevenin's theorem to the rescue. There is no reason why you can't convert the more complex circuit into a simple Thevenin's equivalent. Let's see how to do that.

Begin as before by removing the load resistance from the circuit. To find the Thevenin's-equivalent voltage, all we have to do is to compute the amount of voltage between terminals A and B. That shouldn't be too difficult.

In examining the bridge circuit without the load, you may recognize the fact that it actually consists of two voltage dividers connected across the source voltage. If we redraw the circuit as shown in Fig. 13, you will see that more clearly. One voltage divider is made up of R1 and R2, while the other is

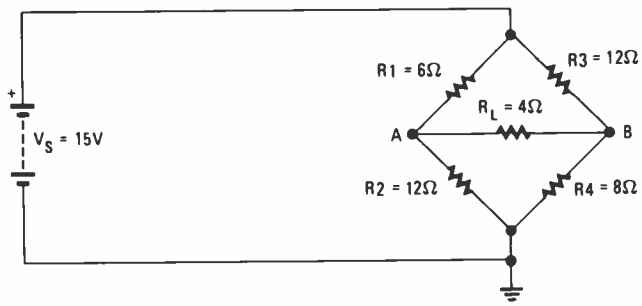


Fig. 12—Bridge circuits are difficult to solve with more basic methods. However, they can easily be analyzed using Thevenin's Theorem and a little math.

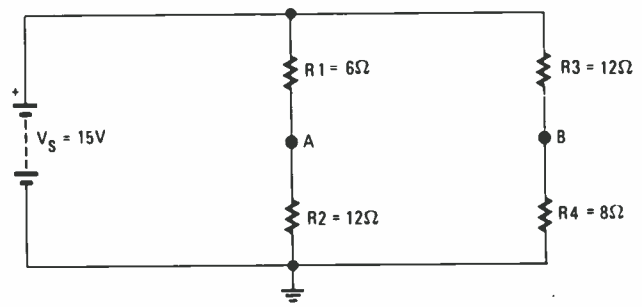


Fig. 13—Even with a bridge circuit, the first step is to remove the load from the circuit before analysis.

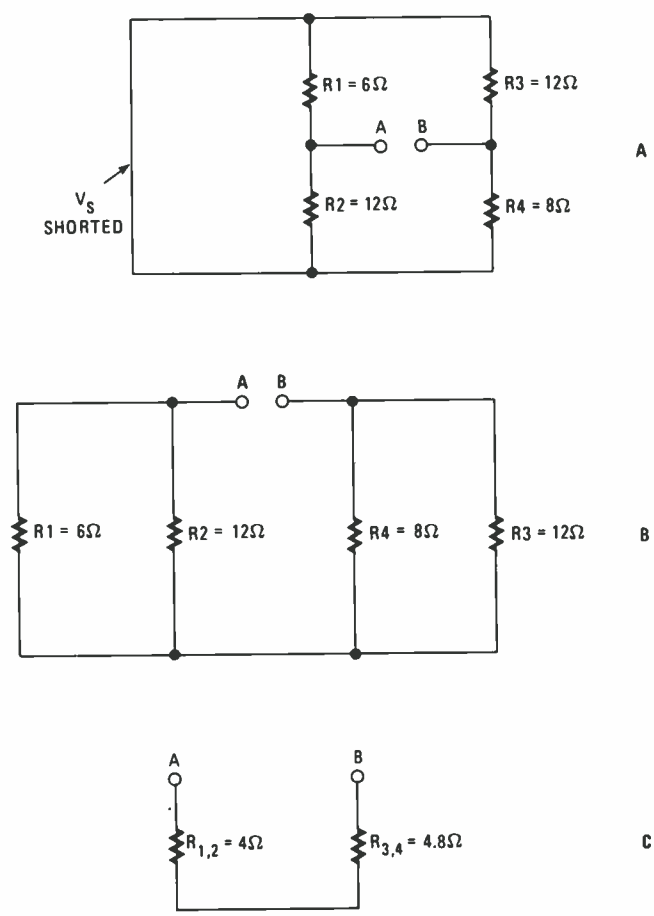


Fig. 14—After shorting the voltage source, the circuit looks a little strange (A), but that can be resolved by rearranging (B). Then we break the resistances down into simpler equivalent forms before final analysis.

made up of R3 and R4. What we wish to know is the voltage between terminals A and B. But to find it, we must first determine the voltage at A with respect to ground and the voltage at B with respect to ground. To do that we can simply apply the voltage divider equation given earlier.

The voltage at point A with respect to ground (V_A) is computed as follows:

$$V_A = V_S R2/(R1 + R2) = 15 \times 12/(6 + 12)$$
$$= 15(12/18) = 15(0.6666) = 10 \text{ volts}$$

The voltage at point B with respect to ground (V_B) is computed in exactly the same way:

$$V_B = V_S R4/(R3 + R4) = 15 \times 8/(8 + 12)$$
$$= 15(8/20) = 15(.4) = 6 \text{ volts}$$

We now know the voltages at A and B with respect to ground. The voltage directly between A and B is simply the difference between those two voltages. From that, V_{AB}, which is also the Thevenin's-equivalent voltage, V_{th}, is:

$$V_{AB} = V_{th} = V_A - V_B = 10 - 6 = 4 \text{ volts}$$

Since V_A is greater than V_B, A is positive with respect to B.

Now let's find the Thevenin's-equivalent resistance. As before, the load is assumed to be disconnected. Next, we short out the source voltage as we did before. The resulting circuit is shown in Fig. 14A. That is a good example of how not to draw a schematic diagram. To understand the circuit better, we can redraw it as shown in Fig. 14B. As you can see, we have a simple series-parallel combination circuit made up of R1 and R2 in parallel, and R3 and R4 in parallel, and the two combinations in series. We can apply the standard resistor formulas to the problem.

First, we find the parallel resistance of R1 and R2, which we call $R_{1,2}$. That is done as follows:

$$R_{1,2} = R1(R2)/(R1 + R2) = 6(12)/(6 + 12)$$
$$= 72/18 = 4 \text{ ohms}$$

The parallel combination of R3 and R4 we can designate as $R_{3,4}$ and it is computed as follows:

$$R_{3,4} = R3(R4)/(R3 + R4) = 12(8)/(12 + 8)$$
$$= 96/20 = 4.8 \text{ ohms}$$

The total resistance then is simply the sum of the two equivalent resistances shown in Fig. 14C. To find the total all we do is add the two equivalent resistances:

$$R_T = 4 + 4.8 = 8.8 \text{ ohms}$$

Of course, the total resistance is the Thevenin's-equivalent resistance, R_{th}.

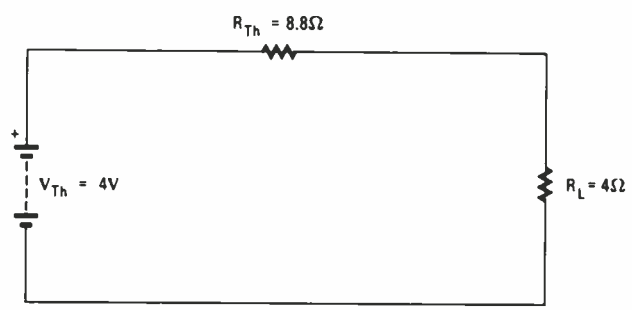


Fig. 15—The equivalent of the bridge circuit looks like all the other equivalent circuits, indicating the usefulness of Thevenin's Theorem in circuit analysis.

At last we can draw the full Thevenin's equivalent, which is illustrated in Fig. 15. A DC voltage of 4 volts is connected in series with its resistance of 8.8 ohms. Our load resistance is 4 ohms. Calculating the voltage across the load resistance is now easy.

To do that, we first find the total circuit resistance, which in this case is the Thevenin's-equivalent resistance plus the load resistance, or:

$$R_T = R_L + R_{th} = 4 + 8.8 = 12.8 \text{ ohms}$$

Next, we find the total circuit current with Ohm's law:

$$I = V_{th}/R_T = 4/12.8 = .3125 \text{ amperes}$$

Now the voltage across R_L is simply that current multiplied by the load resistance, or:

$$V_L = IR_L = .3125 \times 4 = 1.25 \text{ volts}$$

Exercise Problem

2. Now have one more go at using Thevenin's theorem yourself. Refer to Fig. 16. Calculate the Thevenin's equivalent voltage and resistance.

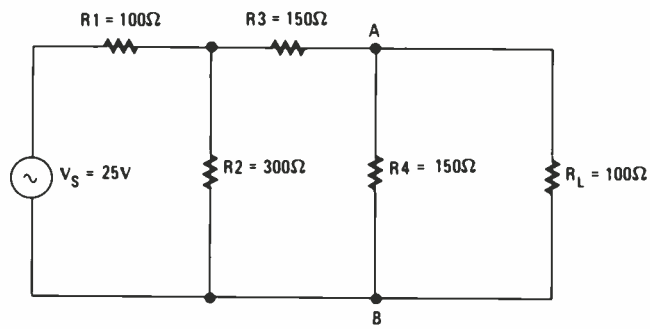


Fig. 16—Follow the basic steps for using Thevenin's Theorem when working the practice problem for this circuit.

Next month we'll cover some of the more interesting techniques for circuit analysis. Till then, practice what you've learned and Theveninize! ■

Answers

1. Refer to Fig. 17A.

a. Remove the load resistance R_L.

b. Calculate the Thevenin's equivalent voltage V_{th} across R3. $V_{th} = V_3$.

Calculate the total circuit resistance $R_{1,2,3}$. R2 and R3 are in series to produce:

$R_{2,3} = R2 + R3$

$= 60 + 120 = 180$ ohms.

R_{23} is in parallel with R1. Since R1 and R_{23} are equal, the equivalent is:

$R_{1,2,3} = 180/2 = 90$ ohms.

Find the total current:

$I = V_S//R_{1,2,3} =$

$10/90 = .111A.$

Compute the current in R3(I_3):

$I_3 =$

$V_S/(R2 + R3) = 10/180 = .0555$ A

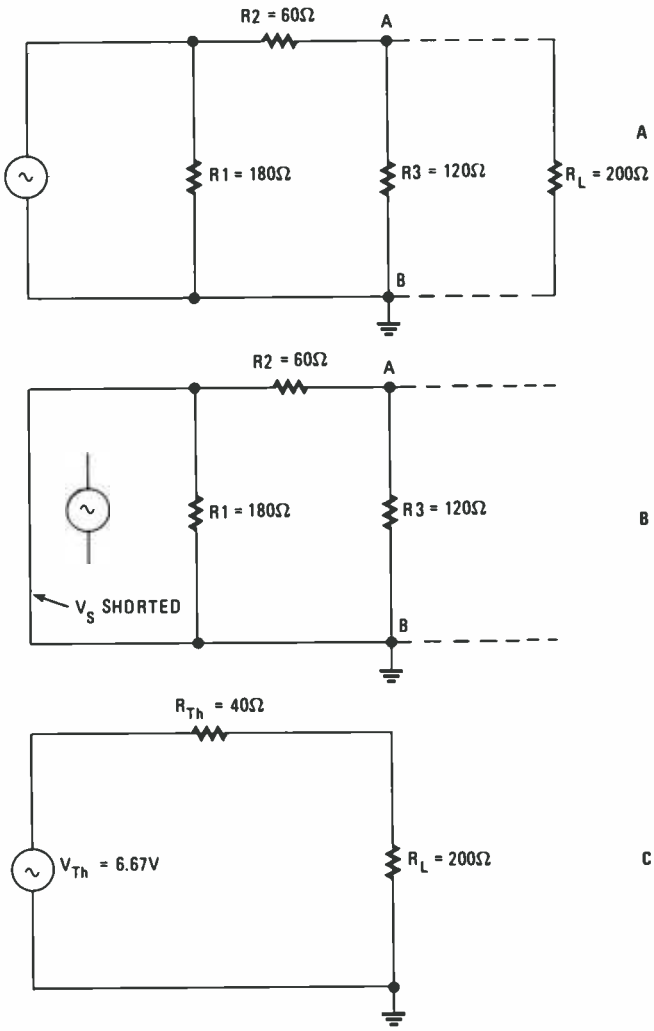


Fig. 17—When you redrew the circuit for various stages of the analysis they should have looked like these.

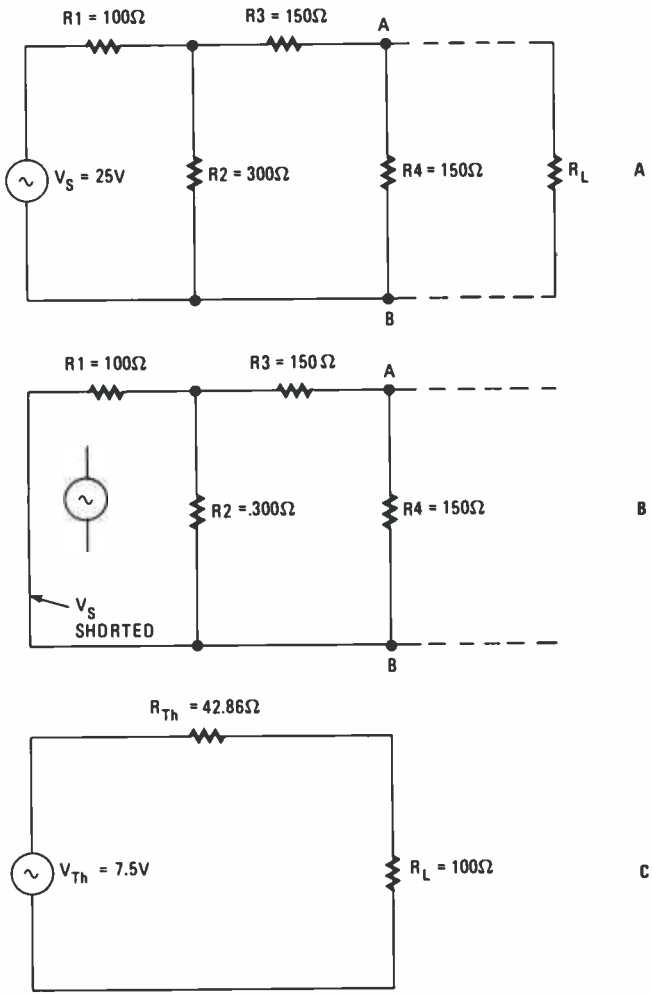


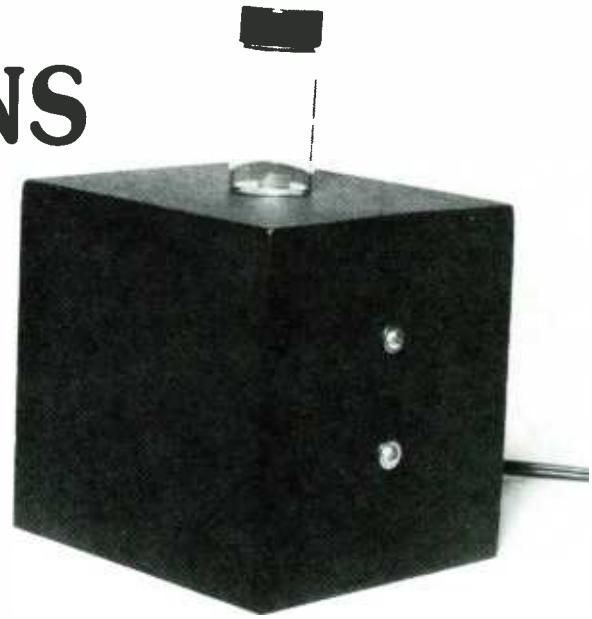
Fig. 18—If you didn't get this problem right, it is strongly recommended that you choose one of the other circuits in the article and try to solve it without referring to the text until you are finished.

Calculate the output voltage across R3:
$V_3 = I_3R3 = .0555(120) = 6.67$ volts.
$V_{th} = V_3 = 6.67$ volts.
c. Calculate the Thevenin's equivalent resistance.
Short V_S. That shorts out R1 and puts R2 and R3 in parallel. See Fig. 17B. $R_{2,3}$ the resistance of R2 and R3 in parallel is:
$R_{2,3} = R2(R3)/(R2 + R3)$
$R_{2,3} = 60(120)/(60 + 120)$
$R_{2,3} = 7200/180 = 40$ ohms
d. The equivalent circuit is shown in Fig. 17C.

2. Refer to Fig. 18.
a. Remove the load resistance R_L.
b. Calculate the Thevenin's equivalent voltage across R4 and terminals A – B. To do that first find the total circuit resistance. R3 and R4 are in series so their total resistance is:
150 + 150 = 300 ohms.
That appears in parallel with R2. Two 300-ohm resistances in parallel produce:
300/2 = 150 ohms.
That is in series with R1 to produce a total of:
150 + 100 = 250 ohms.
Calculate the circuit current with Ohm's law.
$I = V_S/R = 25/250 = .1A$.

Compute the voltage across R1(V_1).
$V_1 = IR1 = .1(100) = 10$ V.
Find the voltage across R_L(V_2). By Kirchhoff's law that is:
$V_2 = V_S - V_1 =$
$25 - 10 = 15$ volts.
Calculate the current in R3 and R4.
($I_{3,4}$). $I_{3,4} = V_2/R3 + R4 = 15/300 = .05A$.
Calculate the output voltage across R4 and A-B.
(V_4). $V_{th} = V_4 = I_{3,4}(R4) =$
$.05(150) = 7.5$ volts.
c. Calculate the Thevenin's equivalent resistance: Short V_S.
R3 and R4 are in series
($R_{3,4}$) = R3 + R4 = 150 + 150 = 300 ohms.
Also:
$R_{3,4} = 300$ ohms
in parallel with R2 is
$R_{2,3,4} = 300/2 = 150$ ohms.
With V_S shorted, R1 appears in parallel with R2 and R3/R4 in series. The total resistance is 150 in parallel with 100 or:
$R_{th} = R1(R_{2,3,4}/R1 + R_{234})$
$R_{th} = 100(150)/100 + 250 = 15000/350 =$
42.86 ohms
d. The equivalent circuit is shown in Fig. 18C. ■

MAGNETIC JUMPING BEANS



Fred Astaire, even at his best, never pulled the moves you'll see this project do!

By Stan Czarnik

IMAGINE DOING THE FOLLOWING: PLACE A SMALL METALlic chunk in a glass vial. Seal the vial. Place the vial on a black box, and the chunk vibrates wildly with no visible means of propulsion.

The chunk is a magnet, the box emits an alternating magnetic field, and so the magnet vibrates. Even to those who know exactly what's going on, this simple trick seems strangely amusing. With a small power transformer, some magnet wire, and a few other parts, you can create your own "jumping bean simulator" in two or three hours.

Step One

First, you need to wind an electromagnet and make a mounting bracket. Obtain a fairly stiff strip of non-ferrous metal about ½- or ¾-inch wide. The material in the photos is brass; but aluminum or copper will work too. The length of the strip will depend on the size and shape of the cabinet; more on that later. Drill a hole in the center of the strip that is just large enough to accommodate a steel screw from your hardware collection. The screw should be 1½- to 2-inches long. If possible, use a flathead screw. Push the screw through the hole, fit a perforated fiber washer onto the opposite end, and secure it with a nut.

You're now ready to make the electromagnet. Plan on winding at least 8 or 10 layers of #20 magnet wire around the screw. You will need between ¼ and ½ pound of wire, depending on how large a coil you wish to make, so make sure to get enough. Nothing is worse than realizing that you don't have enough wire to finish the job when it's too late to do anything about it.

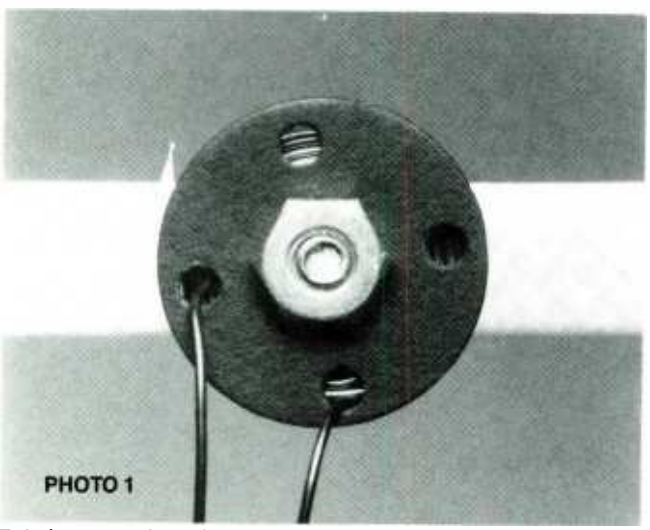


PHOTO 1

This is a rear view of the electromagnet. Note how the leads have been drawn through two of the holes in the perforated washer to prevent the coil from unraveling.

Begin the electromagnet by threading a few inches of wire through one of the off-center holes in the washer. That helps keep the windings from becoming undone. The windings needn't be perfectly even, but do your best. Give yourself plenty of time to wind the coil, it may take a while. When you're done, the windings should be tight enough to hold the metal strip firmly against the head of the screw and the fiber washer against the nut. Terminate the winding in the way you began, by threading a few inches of wire through one of the off-center holes, as shown in Photo 1. The leads coming off the coil should be long enough to work with easily once the assembly is mounted.

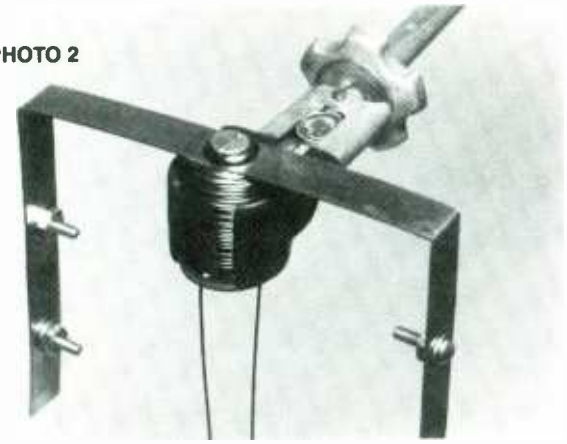
The Cabinet

The cabinet can be made of wood or plastic. The top, or what will be the top, of the box should be no more than about ¼-inch thick. Very heavy material may put too much distance between the electromagnet and top surface of the cabinet. The case in the photos is a wooden knick-knack box, painted black, the top of which is about ⅛-inch thick. Also, **do not** choose a cabinet that is too small. The unit heats up very rapidly and the components need as much air around them as possible.

Now is the time to decide how you will mount the coil bracket inside the box you have chosen to use. The important part is to make sure the end of the electromagnet fits tightly against the inside top of the cabinet. One way, but not the only way, of doing that involves bending the metal strip into the form of a "U," as shown in Photo 2. The *base* of the "U" should match the inside dimensions of the box along which you will be placing the bracket. If the ends of the strip extend past the bottom of the cabinet, they must be bent or cut. The bracket can be mounted before anything further is done.

The circuit is very simple, as you can see in Fig. 1. The electromagnet is connected to the secondary of a small power transformer. The transformer the author used (a Radio Shack

PHOTO 2



Here's the electromagnetic coil mounted on the bracket. The hardware has been inserted to show the position of the holes used for mounting the unit in the cabinet.

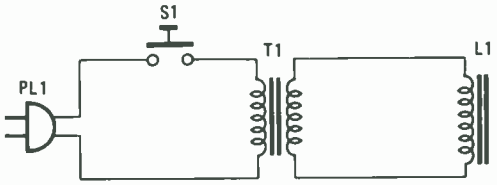
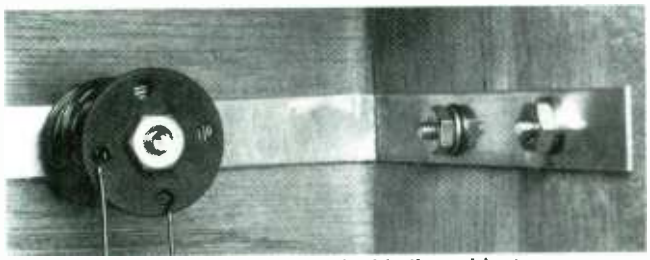


Fig. 1—This is all it takes to build the Electronic Jumping Bean project. This is one project that takes little time to build, but many days to kick the habit of playing with it.



When the coil bracket is secured inside the cabinet, you should make sure the coil is right up against the top of the cabinet. A good, snug fit along the sides is also desirable.

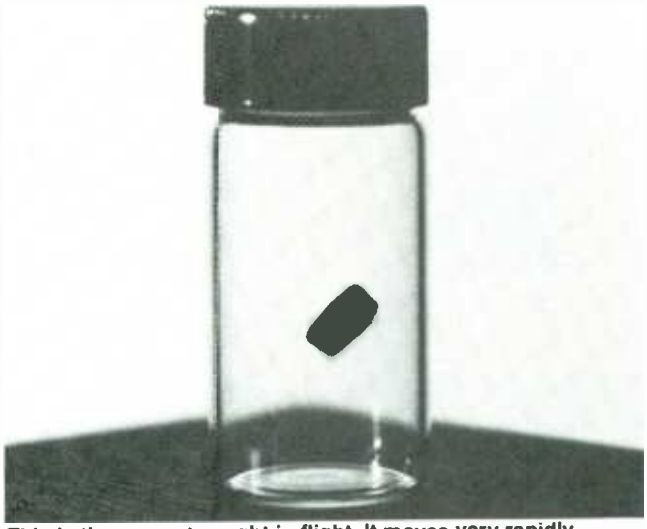
PARTS LIST
FOR THE ELECTRONIC JUMPING BEAN

L1—Electromagnet (see text)
PL1—AC plug with line cord
S1—Momentary-contact pushbutton switch
T1—Any 6- or 12-volt power transformer (such as Radio Shack 273-1352)

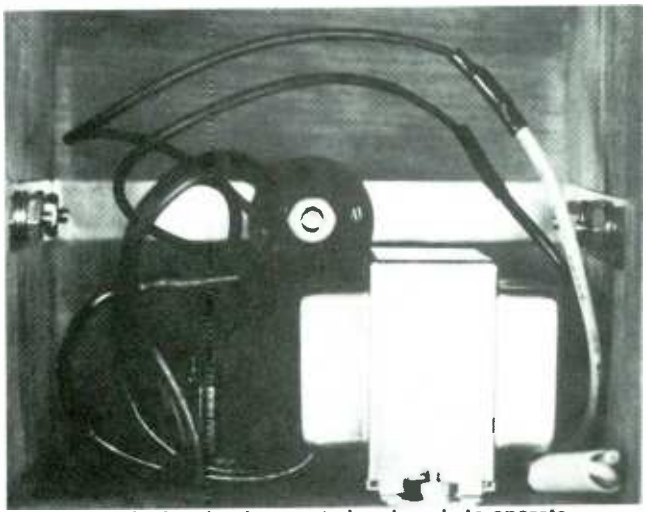
Project box (see text); perforated fiber washer; steel screw, 1-½- to 2-inch; magnet (see text); magnet wire, 20 gauge, ½ pound spool; brass strip; clear glass or plastic vial; line cord; heat-shrink tubing; hardware; solder, etc.

unit) was a center-tapped, 12-volt secondary type. Using either the 6- or 12-volt output did not seem to make much of a difference. The author used the 6-volt arrangement. The primary of the transformer is connected to a 117 VAC line cord and a momentary-contact pushbutton switch. A neon lamp may be added to the circuit (parallel to the transformer primary) to indicate that the unit is on.

A momentary-contact switch is used for a good reason. Be sure to use one to avoid overheating the coil through overuse.



This is the magnet caught in flight. It moves very rapidly inside the vial in a helter-skelter fashion.



Shown here is the circuit mounted and ready to operate. Note the large air space around the magnetic coil. That helps keep it cool. Do not use a cabinet that is too small.

The electromagnetic coil becomes *very* hot *very* quickly and the momentary switch prevents the unit from being left on unattended. Also, resist the temptation to operate the unit for more than 20 or 30 seconds at a time.

The connections between the transformer and the coil can be soldered and insulated before the transformer is mounted. The rest of the work may have to wait until everything is in place. If the line cord does not fit tightly in the grommet, tie a knot (such as an underwriter's knot) in it, or consider using a strain relief. Attach a plug to the cord, turn the box right side up, and you're done.

You may have a little trouble finding a magnet small enough (as well as strong enough) to jump with any degree of energy. The one in the photos is only ⅜-inch long. If you do not wish to use the supplier mentioned in the Parts List, then you can make a small magnet from a larger one you may already have. Wrap it in cloth or paper, and break it into smaller pieces with a pair of pliers and a vice. Do not bang on the magnet as that reduces its strength.

Do not use a magnet that you might want to use for some other purpose. What you have built is very similar to a bulk tape eraser or degausser. The alternating field will weaken and eventually neutralize the power of the magnet. ■

By Marc Ellis

ELLIS ON ANTIQUE RADIO

A little housekeeping is worth a lot of troubleshooting!

☐DURING THE LAST COUPLE OF months, we've been working on the restoration of a Zenith 7S232 BC-SW set. The set is a large table-model radio with some very interesting features, including a tuning dial of unusual and beautiful design. Called a "shutter-dial," it contains a mechanical arrangement to automatically display the correct set of calibrations for the band that is in use. The radio also features flywheel-aided vernier tuning, a magic-eye tuning device, and individual indicator scales for the tone control, volume control, and bandswitch.

I introduced the set in the August column, giving a fairly complete physical description, and noting some of the more-obvious problems. In September, we concentrated on the dial. An internal jam had caused the mechanism to stick, and a previous owner had tried to resolve the problem by applying brute force to the bandswitch. That resulted in some of the metal parts in the dial being badly buckled and twisted. The problem looked a lot worse than it really was, though.

Once the dial was removed from the set and dismantled, the distorted parts were easily straightened in a vise. After reassembly, the shutter-dial assembly worked well, and was set aside for later installation.

In the September column, I also fired up the set for the first time. Starting at reduced line voltage, I slowly increased to the full 117-volt line voltage as it became apparent that the electrolytic capacitors were going to be OK and no short circuits were developing. The set then came to life, though it would pick up only a few strong local broadcast stations. There was no trace of hum, but signals were distorted and accompanied by strong oscillation. Nothing could be heard on either shortwave band.

Clean, Adjust, and Straighten!

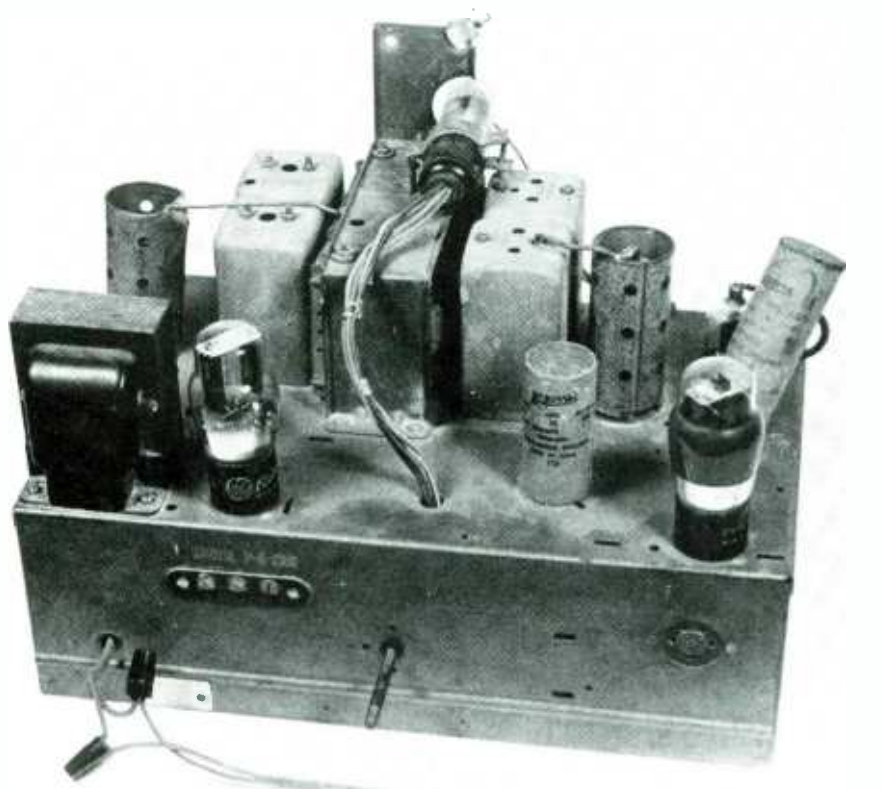
As I mentioned at the time, it was too early to be concerned about the oscillation. Instability of that kind can easily be caused by poor ground connections at tube shield cans, and would be remedied by the deep cleaning that was to come next. Which brings us to the point of this month's column.

It doesn't pay to get too analytical about troubleshooting an old set until you've given it a thorough cleaning, tightened and readjusted all loose components (especially tube shield-cans), and subjected everything to a searching inspection.

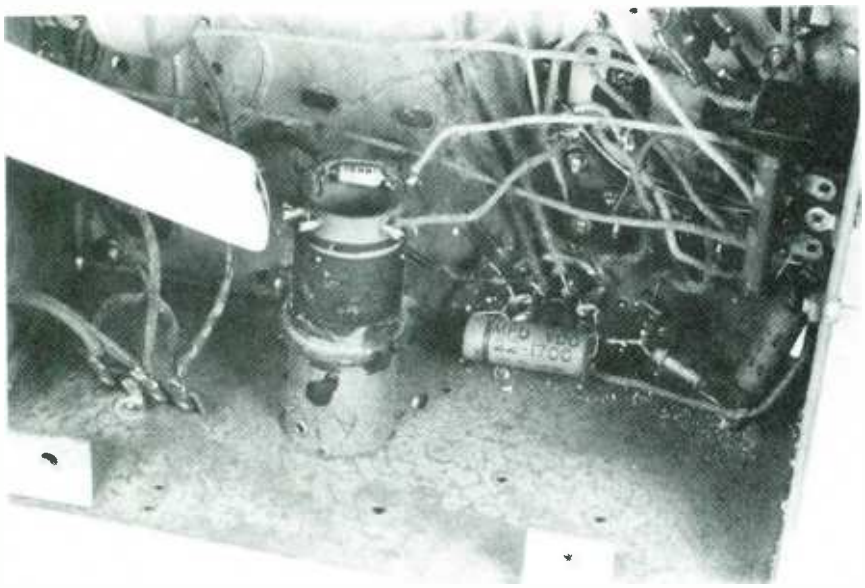
A preliminary inspection of the chassis showed that the radio was physically intact—but suffering from the effects of time, "quick-and-dirty" servicing, and storage in a less-than-ideal environment. Aside from the usual dust and grime, I could see evidence of corrosion and oxidation on both painted and bare-metal surfaces. While there was nothing that wouldn't clean up nicely, the set was obviously never going to look brand-new again. But it would at least be very presentable.

Checking Topside

Looking at the top of the chassis, I could see that both tube shield cans were improperly mounted on their bases and very loose. One of the shields had been crudely pinched at the top to give the grid lead enough clearance to extend much farther down into the can. That had been done so that the original glass ("G" style) 6A8 tube could be



Here is how the set looked when as this month's restoration work was started. Note the stretched grid wire and pinched shield can on the tube behind the power transformer.



Using a vacuum cleaner helped remove spider webs and other accumulated debris from the tight spaces underneath the chassis. Once that was done, it was time to get down to the serious troubleshooting.

replaced by its much-shorter metal equivalent.

The top-mounted electrolytic condensers (capacitors) were both Aerovox replacements rather than originals. And the universal mounting bracket on one of them had become bent out of shape, leaving the capacitor to hang by its wires. Finally, part of the tone-control selector switch (a multiple-contact wafer type) was broken off. But I was relieved to see that the missing part of the wafer had carried only unused contacts, so operation would be unaffected.

Remounting the loosened electrolytic capacitor was an easy job. It had been held in place by a simple screw-attached bar that extended across the mounting hole. The bar had been bent out of shape, but was easily removed, straightened in a vise, and replaced. With the electrolytic standing straight and firm again, I turned my attention to the problem of the tube shield.

Luckily, I happened to have a good "G"-type 6A8 in my tube collection. With that substituted for the metal version, there was no longer any need for the shield-can top to be pinched in. Straightening out the dent was fairly easy and left only a few visible ripples. As it turned out, though, I didn't have to use the repaired can because I also happened to have an identical—and perfect—replacement in my junkbox.

When working with the shield cans, I found that they were designed to bayonet-lock firmly onto chassis-mounted flanges. That arrangement guaranteed a good electrical connection between chassis and can. However, as received, those locks were not engaged, and the cans were simply held in place by friction. The lack of good electrical contact could easily explain the oscillations I'd observed during my initial test of the radio.

Since the top of the set definitely needed a deep cleaning, I decided there was no time like the present. To provide better access, I carefully removed all the tubes and tube shields. I also removed the metal tuning-eye/tuning-capacitor bracket.

The capacitor was suspended from the bracket by three threaded studs passing through grommet-lined holes. Besides making it easier to clean the tuning capacitor and surrounding chassis, the removal of that bracket gave me the opportunity to replace the dried-out and hardened "shock-absorbing" rubber grommets.

The overheated burned resistor was replaced with a new one of the proper value. Finding problems like that up front eases troubleshooting later.

I began cleaning by going over the chassis with a cloth kept moistened with soapy water and periodically wrung out. A small screwdriver was used to poke the cloth into difficult crevices, like the space between adjacent coil cans. As evidenced by the condition of the wash water, an astonishing amount of dirt was removed in just that manner.

The soap treatment was followed up by rubbing with Brasso—a metal polish that also works well on glossy paint (such as used by Zenith on most chassis of that period). The Brasso was used not only on the chassis, but also on all coil cans, transformer cans, and tube shields. With the tubes carefully cleaned up using a damp cloth, the shield cans firmly locked in place, and the tuning-eye/tuning-condenser bracket reinstalled, the chassis top was beginning to look quite presentable, if not impressive!

A word of warning about cleaning tubes: The type markings on most tubes of this period appear to be etched in the glass, but they are apparently only stenciled using some very easily removable paint. One vigorous swipe of a damp cloth may be enough to completely obliterate the marking, leaving the tube embarrassingly blank. A word to the wise: when you clean the tube, carefully avoid the area around the stencil!

The Situation Underneath

Conditions under the chassis were just about what you might expect of a radio that was probably stored in a basement or garage for about thirty years, and my first official act was to get out the vacuum cleaner to remove the dust, debris, and cobwebs. In areas that were especially dirty, the vacuum worked better after the debris was first loosened with a soft brush.

As I scrutinized all of the components for signs of overheating or other failure, my eye was almost immediately drawn to a big orange resistor that proved to be the screen dropping resistor for the 6K7 IF amplifier. At some time in the past, the resistor had become so hot that much of its paint had burned off. The scorch marks on the chassis above the component also suggested severe overheating.

(Continued on page 101)

FRIEDMAN ON COMPUTERS

By Herb Friedman

A dual-purpose device that backs up protected floppies, and more.

With few exceptions, until recently software was generally written for a specific family of computers (IBM, Apple II, Macintosh, etc.). Neither the program, its files, nor the disk format was compatible between systems. Not only was software compatibility lacking, but much of the software was protected, which meant that the user could not make copies of the distribution disk.

While proponents of protection put forth many rational and justified arguments, they conveniently avoided the problem of something going wrong with the distribution disk. In such situations the user was left high and dry.

Since I have been into personal computing from the very start, I can speak about the problem with some authority. I have some excellent protected programs that were sold from someone's kitchen table. As a general rule, most of the protected programs came with a backup disk, or a duplicate could be purchased at a moderate price if the defective distribution disk was returned.

Unfortunately, when a backup disk was needed, the source was long gone. Either the programmer had made so much money that he had retired (which is what happened in the case of the best-ever spelling checker), or he was bought out by a larger distributor, and all traces of the original source had vanished.

After several years of enduring the vanishing-distributor problem with software for Radio Shack's Models 1, 3, and 4 computers, I avoided the problem when the IBM PC came along by using the COPYIIPC software from Central Point Software. COPYIIPC could make a backup of most protected software. And as fast as a new protection scheme was introduced, COPYIIPC was upgraded to bypass the protection. So, I can still use software for which there is no longer any trace of a distributor. (Actually, I often think I see the programs advertised under different names; but the distributors always deny any connection to the original.)

Occasionally I came across software that could not be copied by COPYIIPC, and for those rarities, Central Point Software had a special disk adapter that plugged into the PC and bypassed the normal disk controller, allowing virtually all software to be backed up.

```
A:\>dir

 Volume in drive A is DLX_OPT_BRD
 Directory of  A:\

OBSETUP  EXE      7940   3-14-88   9:48a
TC       EXE     66249   4-11-88  10:02a
TCS      EXE     48026   4-11-88  10:04a
TCM      EXE     66298   4-11-88  10:03a
TE       EXE     33203   4-11-88  10:08a
MCP      EXE     59044   3-25-88   8:15a
MCD      BAT        17   3-14-88   9:57a
MCOPY    BAT        22   3-14-88   9:56a
MDC      BAT        20   3-14-88   9:56a
MDEL     BAT        18   3-14-88   9:56a
MDIR     BAT        21   3-14-88   9:56a
MFORMAT  BAT        21   3-14-88   9:56a
MMD      BAT        17   3-14-88   9:56a
MRD      BAT        17   3-14-88   9:57a
MTREE    BAT        16   3-14-88   9:57a
MTYPE    BAT        16   3-14-88   9:57a
PK       COM      9968   3-22-88   6:49p
       17 File(s)      59392 bytes free

A:\>
```

Fig. 1—The directory for the supplied software shows both the copy-protection programs and the commands—which have an M prefix—that are used when processing Macintosh disks and software.

Enter Big Mac

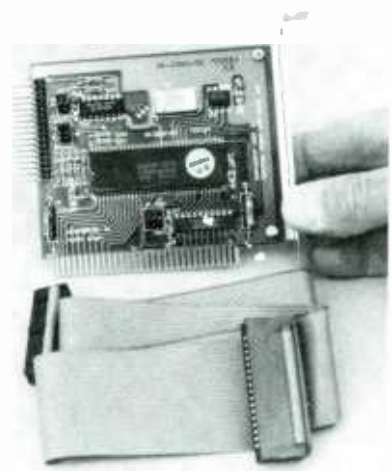
Well, when you lick one problem another is certain to arise. Sometime during the last year or so, the Macintosh computer got a strong toehold in business. Until then, the IBM PC was virtually the standard of reference for business use because the best of the business programs were written for the PC. There were few quality business programs for the Macintosh. On the other hand, because of its graphics capability and ease-of-use, the Macintosh was favored by schools, hackers, and the new generation of graphic artists.

But within the past year, much of the heavyweight business software has been available in both IBM and Macintosh versions, and the Macintosh is rapidly becoming a serious contender in the business world. While a program written for the IBM won't run on a Macintosh (and vice versa), the data files are usually 99.9–100% compatible. For example, the data/text files of Macintosh and IBM versions of Microsoft's *Word* are essentially compatible. You could interchange the *Word's* data files between the Macintosh and the IBM computers.

Although the easiest way to interchange data is by disk, even if the disks are the same 3.5-inch format, IBM and Macintosh disks aren't compatible. You can't read from or write to a disk if it's on the wrong computer. But just as with protected software, once again it's COPYIIPC to the rescue, this time in the form of the *COPYIIPC Deluxe Option Board*.

COPYIIPC Deluxe Option Board

The Deluxe Option Board and its software allows IBM PC/XT/AT and



The Deluxe Option Board is a half-size adapter that plugs into the computer. The "universal" matching cable shown is provided with the board.

PS/2 Models 25 and 30, as well as most IBM compatible computers, to make archival backups of virtually all IBM software—essentially, anything that doesn't use a protection scheme that involves physical damage to the disk itself. In addition, if your computer has a 3.5-inch drive, or if it can be upgraded or expanded with a 3.5-inch drive, you'll be able to transfer files from a PC/XT/AT, PS/2 Model 25 or 30, to a Macintosh disk, and vice versa.

existing disk-drive cable connection from the motherboard to the Deluxe Option Board and connect the cable from the Option Board to the motherboard. Dual connectors on the Deluxe Option Board allow the adapter to be used in computers using either card-edge or pin connectors.

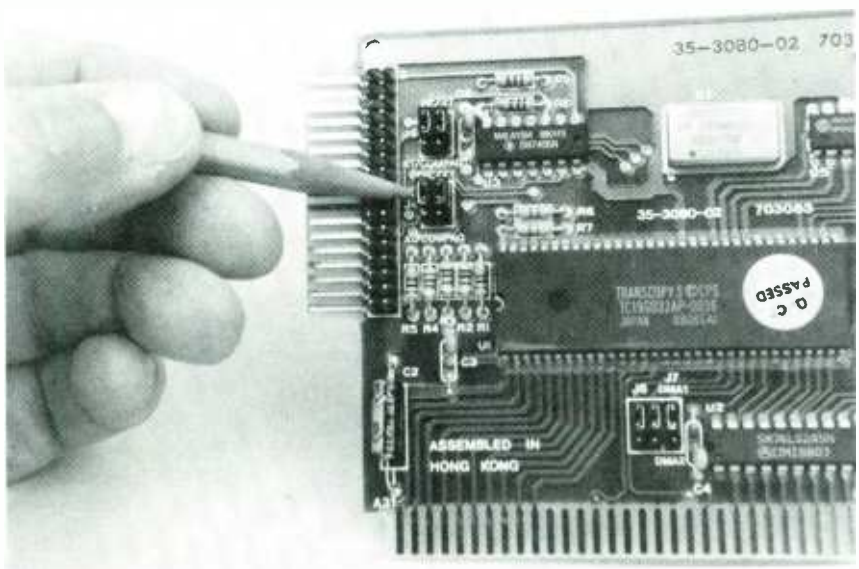
Bit Bypass

Most disk-protection schemes depend on certain quirks of existing disk

having 360K, 720K, 1.2 Meg, or 1.44 Meg drives. There are several limitations when using 3.5-inch drives, among them: the source and target drives must be physically configured as A: and B:; both drives must be internal (not connected to an external drive port); support is guaranteed for 3.5-inch IBM drives (mixed results were attained on compatible brands); you cannot read from a 360K or 720K drive and write to a 1.2- or 1.44-Meg drive; you cannot read from or write to 1.2-Meg diskettes (5.25 inch), nor write to 1.44-Meg diskettes (5.25 inch).

In a typical PC/XT configuration with a 5.25-inch floppy and a hard disk, a 3.5-inch drive can be installed internally as the B: drive. The option board automatically recognizes either single- or double-sided 3.5-inch Macintosh disks. Of course, the 3.5-inch drive can be used as a conventional IBM drive.

I have barely touched on the applications of the COPY||PC Deluxe Option Board. For more information write to: Central Point Software, Inc., 15220 N.W. Greenbrier Pkwy. #200, Beaverton, OR 97006. Or call 503/690-8090 for information. ■



Plug-in jumpers automatically program the board for PC/XT or AT/Compaq operation. The user simply moves the jumpers to the appropriate terminals.

The board and its software give the computer the same kind of disk-duplication technology used by many commercial disk duplicators. As illustrated in the screen print shown in Fig. 1, the software provides the required Macintosh disk commands, such as MCOPY, MTREE, MTYPE, etc.—which are self-explanatory because they are similar to the PC-DOS commands. (Simply eliminate the "M" and you get, COPY, TREE, TYPE, etc.)

As shown in the photograph, the Deluxe Option Board—which must be jumpered for PC/XT- or AT/Compaq-type computers—comes with a connecting cable. The board is installed adjacent to, or near the existing disk controller. The normal connection from the existing controller is moved to the Deluxe Option Board, and the supplied cable is connected to the existing disk controller. If your computer has an all-in-one motherboard that also contains the disk controller, you simply move the

controllers. The Deluxe Option Board gets around the protection by functioning as its own disk controller—without any quirks. Unlike conventional copying schemes that copy only data from the source to the target disk, the COPY||PC system copies everything: sector IDs, gaps, sync bytes, address marks, and clock bits. The target copy is as exact a copy of the source disk as is possible.

Because the Option Board provides a bit-by-bit copy, the same computer can also copy non-IBM disks in standard-format for the Atari and Apple computers. However, not all *protected* Atari- and Apple-format disks can be copied. Also, "flippy" disks cannot be copied; and keep in mind that not all IBM drives are capable of reliable reads and writes of the GCR Apple format.

Drives

The Deluxe Option Board works in either a one or two floppy-disk system

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By Marc Saxon

SAXON ON SCANNERS

Get nine-band coverage/16-channel programmability from a handheld scanner

☐THE *COBRA SR-12* IS CERTAINLY A handful of scanner! Sporting a low-end price, it allows you to program 16 channels of your choice into the unit and watch it scan through the entire batch of them in only one second.

The SR-12's frequency range is most respectable, covering the 30- to 50-MHz VHF low band, the 118- to 136-MHz VHF aeronautical band, the 136- to 174-MHz VHF high band, and the UHF spectrum straight through from 406 to 512 MHz. That's no less than two ham bands, and the most popular public safety, industrial, federal, aeronautical, and maritime bands.

Just because the scanner sells for less than $200, don't think it's a bare-bones unit—not at all. Some of the features offered in the Cobra SR-12 include rapid search/scan (at 25-frequencies per second), full programmability with a direct-access keyboard, single-channel manual step-through, channel delay and lockout, priority channel, backlit LCD display, and battery-power indicator. The accessories supplied with the Cobra SR-12 are the rubberized antenna, AC power supply and battery charger, earphone, and carrying case.

The scanner has an IF selectivity of 50 dB at ±25 kHz, and an RF-sensitivity range of between 0.3 and 0.8 μV (for 12-dB S/N) depending upon the band, as with most handheld scanners. For more information on the SR-12 write to Cobra Consumer Electronics Group, Dynascan Corp., 6500 West Cortland Street, Chicago, IL 60635, or circle the appropriate number on the Free Information Card.

Modification-Data Clamor

Ever since we mentioned that the "missing" portions of the 800-MHz band could be restored in the Realistic PRO-2004 scanner, we have received much mail asking for adding various "missing" frequency bands to many other scanners.

Permit me to point out that you can make some modifications or perform some programming tricks to several other scanners in order to get some extra frequency coverage. For the most part, however, it's not usually something that can be successfully and/or easily accomplished.

In any event, you can't snip out a diode and suddenly add the 118- to 136-MHz or 225- to 400-MHz VHF/UHF aeronautical bands to a scanner that was intended for basic VHF (low and high) and UHF band reception. That such a stunt restored the cellular telephone frequencies in the Realistic PRO-2004 has apparently given many scanner owners the impression that that was an amazing discovery that offers miraculous frequency-expansion potentials for all scanners in the *free world*. Not so!

Several reprogramming tricks have been offered for frequency expansion in some scanners. Of those we have tried, most are complex and produce mixed (and generally disappointing) results. Keep in mind that the "missing" frequencies in the Realistic PRO-2004 were within the overall frequency range of that scanner. In fact, the scanner originally received those frequencies and was then factory-modified to blank-out the PRO-2004's ability to pick them up. So, the user-modification was merely restoring that ability, it was not creating new capabilities from scratch.

Cobra's SR-12 handheld scanner features electronic/non-crystal tuning, a 16-channel programmable memory, 8-digit LCD display, and 9-band coverage, including the aeronautical band.

While programming procedures or internal modifications can cause the frequency display of a scanner to show a wide variety of apparently "new" frequencies, it doesn't mean that the scanner is actually picking up any signals on the frequencies being displayed. In fact, when you get more than a few-hundred kHz past the limits of the manufacturers' original design parameters for frequency coverage, the unit simply isn't going to perform.

Your best hope would be if you could perhaps program into your scanner the ability to pick up "new" frequencies within the set's overall frequency coverage. For instance, if the UHF band on your scanner normally accepts programming in 25-kHz increments, you may be able to convince it to accept frequencies spaced closer together. Even so, not all scanners will jump through that "loop" for your pleasure.

The bottom line is that (with the exception of the 800-MHz band cellular frequencies) scanner manufacturers would be only too happy to offer their customers the ability to scan the widest frequency range possible within the design capabilities of their products. If all it took to make the unit substantially more versatile was adding or subtracting a wire or component from the circuit, or punching up some odd procedures, then they'd have thought of it first.

Please let us hear from you with your questions, station photos, monitoring hints and ideas, etc. Write to: Marc Saxon, *Saxon on Scanners*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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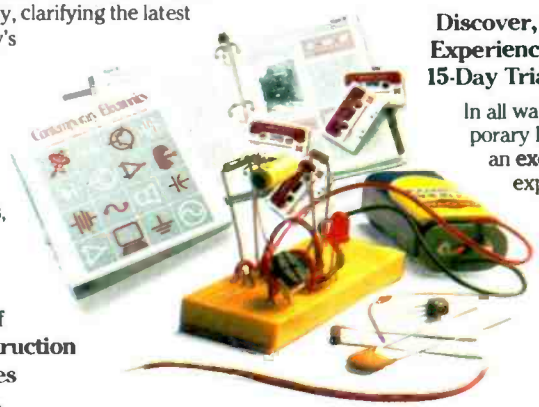

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By Don Jensen

JENSEN ON DX'ING

A pioneer SW-radio show celebrates its 60th birthday

DATING BACK TO 1928 AND THE EXperimental transmissions of station PCJJ (operated by the Philips Laboratories in Eindhoven, Holland), *Radio Nederland's* (RN) weekly "The Happy Station" show this year celebrates its 60th birthday, making it the oldest program on radio! Its 25-kilowatt shortwave transmitter was big stuff in those pioneer-broadcasting days, but it took that kind of lung-power to reach the Dutch East Indies, half a world away.

Today's SWLs can hear it even better, thanks to the 300-kilowatt Radio Nederland relay stations on the West Indian island of Bonaire. Broadcasts are aired every Sunday night (0230 UTC Mondays on 6,165 and 9,590 kHz, and repeated at 0530 UTC on 6,165 and 9,715 kHz).

The Philips test broadcasts had started a year earlier, but in 1928, a young announcer named Edward Startz began the weekly program that he called "The Happy Station." And over the decades, millions of listeners were able to keep in touch with the Dutch through Startz' broadcasts. His verbal trademark was a weekly invitation to listeners to join him for *a nice cuppa tea!*

Eddy Startz retired in 1970, ending one era but beginning another.

He was replaced by 32-year-old Dutch announcer, Thomas Hendrick Meijer, who (along with his family) escaped the Nazi occupation of Holland. As a pharmacy student, he quickly decided that his interests led in another direction, to music and the theater. In 1965, he joined the staff of RN and, for international audiences, changed the Dutch "ij" spelling to "y," becoming Tom Meyer.

Five years later, when Startz left, Meyer became the host of the venerable "The Happy Station" program. Eighteen years later, he's still working the show, though he still has a long way to go to match his predecessor's 41-year tenure at the station.

Tom Meyer, longtime host of Radio Nederland's "The Happy Station" program, the oldest show on shortwave, together with his friend, Klaasje.

Meyer says his ability with languages was one reason he got "The Happy Station" assignment. He spoke fluent English, German, and French, in addition to Dutch, when he started. After a six-week crash course in Spanish, he had a handle on that language as well. He also responds to listeners in Italian and Swiss-German, literally his mother tongue, since his mother is Swiss-born.

In addition to the two Happy Station airings to North America on Sunday night, eight other repeats go out to other parts of the world. And there is a Spanish version of the program, conducted by Meyer, "*La Estacion de la Alegria*," which is aired seven times. The program covers the entire globe!

Meyer, like Startz before him, avoids controversy. He says his goal is "harmony." That, according to the program host, means "harmony in person-to-person relationships...the starting point for greater harmony in world matters." The program is subtitled, "Your Sunday Family Show of Smiles Across the Miles." Meyer says he tries to offer something for everyone. In keeping with the harmony theme, the program steers clear of topics like politics and religion.

The format of the show is roughly half music, half talk. The music covers the entire range from up-tempo jazz to an Irish—that's right, Irish—country and western singer! Meyer's friendly, easygoing chit-chat may or may not be your "cuppa tea," but "The Happy Station" program's longevity says something about its audience.

Radio Nederland cites a Canadian shortwave survey that it says showed that the average number of listeners per Sunday is 200 million, worldwide. If so, that may explain how, after 60 years, "The Happy Station" is going strong.

Another Birthday

Not as easy to log as Radio Nederland is one of the pioneer shortwave broadcasters of Latin America, *Radio Illimani*, which this year celebrates 55 years on the air. It was on July 15, 1933 that Radio Illimani went on the air from La Paz, the capital of Bolivia, with a medium-wave outlet and a one-kilowatt shortwave transmitter made by the Philips Co. in Holland.

Their shortwave service ended in 1975 for technical and economic reasons, but, five years later, under a new director, Radio Illimani returned to the SW band. Today the Bolivian shortwave station operates four recording and broadcasting studios in downtown La Paz. The station operates on medium wave and FM in addition to shortwave.

Now Radio Illimani uses 10-kilowatt

CREDITS: Kenneth Cobb, ME; David Clark, ONT.; Robert Ross, ONT.; Richard D'Angelo, PA; Rowland Archerr, NC; Mark Cody, ONT.; Tom Gavaras, MN; Paul Buer, FL; John Topoleski, PA; Wally Rhyne, NC; Ontario DX Association, P.O. Box 161, Station A, Willowdale, Ontario, Canada M2N 5S8; North American SW Association, 45 Wildflower Road, Levittown, PA 19067

US-made Collins transmitters on 1020-kHz medium wave and on the 6,025-kHz shortwave frequencies. In addition, the station operates on 94 MHz FM. Obviously, only the 6,025-kHz shortwave frequency is possible in North America, and even that isn't the easiest log. Still, it can be heard by patient, careful SWLs, in Spanish or in a local Indian dialect, during the early morning hours before the 49-meter band gets too crowded, say around 0900 to 1000 UTC.

Feedback

Dean Thompson of Belding, MI, has a question about buying a shortwave receiver. "I know nothing about electronics and I am very new to DXing," he writes. "I'd like to shop for a better receiver in my price range. Is there a *Consumer Reports* type of listing of SW receivers? Your column is a big help to a beginner like me, but so much of the information I've found elsewhere is over my head!"

OK, Dean; but first a quick editorial comment. When one is just getting started in shortwave listening, there are questions, seemingly dozens of questions. All of them are important. None of them are dumb.

One common misconception is that it takes vast technical knowledge to be a DX listener. True there are many who are, in fact, very much into the electronics end of the hobby. But there also are many SWLs who are not at all technically inclined and are more than satisfied to simply turn on and tune in to SW signals, without much interest in how their receiver works. Everyone can and should be able to enjoy the radio hobby according to their own individual interests and aptitudes.

Now, as to your specific question. There are several sources for information on buying receivers. But you might want to check out the newly released 1989 edition of *Passport To World Band Radio*, which contains specific information on the most recently released SW receivers in the easy-to-understand format you're seeking.

You can find it in many major book stores. Or you can order it from shortwave equipment dealers advertising in **Hands-on Electronics**, or direct from its publisher, *Radio Database International*, PO Box 300, Penn's Park, PA 18943.

Comments? Questions? What are you hearing on SW? Why not let us know by dropping a line—as Dean did—to *Jensen on DXing*, **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735.

ABBREVIATIONS

DX	long distance (over 1000 miles)
DX'ing	listening to shortwave broadcasts
FM	frequency modulation (modulated)
kHz	kiloHertz (1000 Hertz or cycles)
MHz	megahertz (1-million hertz or cycles)
MW	Medium wave
RBI	Radio Berlin International
RDI	Radio Database International
RMI	Radio Mexico International
RN	Radio Nederland
RNM	Radio Nuevo Mundo
SW	shortwave
SWL('s)	shortwave listener('s)
UTC/GMT	Universal Time Code/ Greenwich Mean Time
VHF	very-high frequency
VOA	Voice of America
VOK	Voice of Kenya

Down the Dial

Here's what others are hearing on shortwave recently. How about you?

China—3,985 kHz. *Radio Beijing* was noted here at 2240 UTC in English with a program about celebrating the Year of the Dragon, complete with a recipe for chicken with black beans and onions!

Columbia—6,170 kHz. *La Voz de la Selva* (the voice of the jungle) from the city of Florencia is being noted with Spanish language programming, time checks, commercials, and identifications, along with lively Latin music at around 1000 UTC.

East Germany—17,880 kHz. *Radio Berlin International* (RBI) is heard here at 1120 UTC with world news in English. Some interference can be expected though.

Ethiopia—9,560 kHz. The station used to announce as the *Voice of Revolutionary Ethiopia*, but more recently the "revolutionary" has been dropped from the announcements. Look for this, in English, with a program called "Introducing Ethiopia" shortly after 1500 UTC.

International Waters—6,210 kHz. Unlicensed *Radio Caroline*, operating from a ship off Great Britain, has been using a medium-wave frequency of 588 kHz for quite some time. It has since added 6,210-kHz shortwave, and has been rather widely heard in North America at various times from around 2300 to 0600 UTC.

Japan—15,300 kHz. *Radio Japan* has been heard with its "Hello America" English-language programming at 2340 UTC.

Kenya—4,934 kHz. Missing from the air for some time, the *Voice of Kenya* (VOK) is again being noted here at around 0300 UTC, with East African news in English at 0300, following a "6-pip" time signal on the hour.

Mexico—11,769 kHz. *Radio Mexico International* (RMI) in Mexico City is being heard in Spanish on this frequency at around 1430 UTC.

Somalia—7,199 kHz. *Radio Mogadishu*, despite some interference from the *Voice of America* (VOA) on an adjoining frequency, has been logged here from sign-on, about 0258 UTC with Somali-language announcements and Islamic prayers. ■

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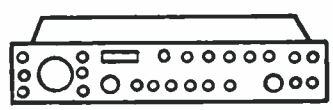

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By Joseph J. Carr, K4IPV

CARR ON HAM RADIO

Computers join forces with ham radio

IN HIS EDITORIAL OF MAY 1988, THE **Hands-on Electronics** editor, Julian S. Martin, correctly recognized that times are indeed changing. And I agree that it's for the better, at least as far as amateur radio is concerned! The reason for his shift (and why he's selling his old file cabinet) is simple: computers.

While **Hands-on Electronics** is not a computer magazine *per se*, hobby electronics is becoming more and more linked to, or enhanced by, personal computers and/or microprocessors. That's why I am going to use this month's column to discuss the link between computers and amateur radio. If you absolutely loath computers, please bear with me, at least this one month.

Computerized Morse Code

Two amateur-radio products intended for Morse-code operators are shown in the photos. Both were originally offered to the amateur market by Micrologic, Incorporated, but are now offered by G&G Electronics (8524 Dakota Drive, Gaithersburg, MD 20877; 301-258-7373).

The *SWL* cartridge is designed to plug directly into the ROM-cartridge slot of the Commodore 64 and 128 personal computers. A line from the receiver's headphone or speaker jack is connected to the analog input of the SWL cartridge. The SWL cartridge-equipped Commodore (when tied to your receiver) can receive, decode, and display both Morse-code and radioteletype (RTTY) signals.

The SWL cartridge acts like a narrow-bandwidth (about 50-Hz) filter, necessitating careful tuning of the receiver. Once it's installed, the C-64/C-128 speaker "beeps" in step with the received code or RTTY signal when the receiver is properly tuned. At that point, the letters represented by the signal begin to flicker across the TV or monitor screen. With the SWL cartridge, it is possible to become a "faster" CW operator than natural ability would allow.

I used the SWL cartridge for about a month while preparing this column. It is a little touchy to learn to operate because of the narrow-bandwidth filter characteristic, but after only a little experience (the first evening), I learned to tune the receiver very easily.

Although Jeff Goldman of G&G told me that his engineers are working on a transmitting version, it took little effort to receive on my SWL/C-128 combo, while transmitting the "old fashioned way"—with either my Vibroplex "bug" or MFJ Electronic Keyer. (I have an older Microlog ASCII-to-CW keyboard that also transmits the letters for me.)

The other Microlog product now offered by G&G Electronics is the *Morse Coach*. That plug-in cartridge (in conjunction with a C-64 or C-128 computer) is designed to give you intense Morse-code practice, and is almost guaranteed to help you improve your speed. The Morse Coach teaches code from the ground up. And once you've gained some degree of proficiency at recognizing the transmitted code, you can use it to increase your speed—progressing at your own pace rather than at a pace set by a class.

An SWL-equipped Commodore 64 or 128, when tied to a ham station can receive, decode, and display both Morse Code and radioteletype (RTTY) signals.

The Morse Coach (in conjunction with a C-64 or C-128 computer) is designed to provide intense Morse-Code practice. It offers three modes of operation: alphabet, practice, and speed test.

There are three modes of operation offered by the Morse Coach: alphabet, practice, and speed test. And it has a variable character rate of from 10 to 99 words-per-minute (WPM), although the rate can be slower than 10 WPM. The reason for sending the characters at a speed of at least 10 WPM is to avoid the 7-8 WPM conceptual plateau that is well known to Morse-code instructors. The Morse Coach keeps track of your errors, and re-transmits characters that give you trouble more and more often to increase your proficiency. The program also keeps track of your progress during any one session, and reports the data on the screen.

The Morse Coach is a lot better than practice cassette tapes, because with tapes there is a tendency to memorize the taped code. In other words, your "progress" is only a reflection of your ability to memorize a single tape. Products such as Morse Coach overcome that limitation by randomizing the practice sessions. The Morse Coach is ideal for practicing for higher-class amateur-radio licenses, as well as practicing for those "speed demon" traffic nets that might be heard on 80-meter CW every night.

Radio Teletype

Ever hear one of those "bee-boo-beep-beep-beep" stations that operate at around 14,080-kHz on the 20-meter band? Those are radioteletype (RTTY) amateur-radio stations. If you buy the

right terminal unit and software, then any Commodore 64 or 128, Apple II, or IBM-PC (or clone) can turn your setup into a RTTY station. Although the conversion to RTTY was once a big deal, the personal computer makes it a game for all.

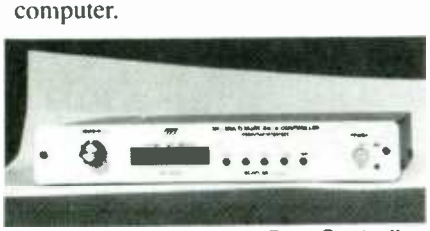
Note: Not all transceivers are suitable for RTTY operation. Some lack the capacity, while others simply cannot withstand the higher average-power output levels required. So check your owner's manual or the manufacturer's literature before going on RTTY.

Packet Radio

With the addition of a Terminal Node Controller (TNC), and a personal computer, your rig is ready to join the high-tech end of amateur radio: "packet" radio. I plan to acquire a TNC for either the Apple II or Commodore 128 in the near future. (I'll report on that venture in some future column). If you haven't seen the packet revolution, then stand back...it's pretty neat.

Amateur Rigs and Computers

The big buzz word used in dealing with computerized anything is interfacing. That is, the joining of a personal computer and some other equipment—in our case, an amateur-radio station. Although some special interface protocols exist, especially among amateur-transceiver manufacturers, many of the "after-market" interfaces expect to see a standard RS-232C serial port on your computer.



The MFJ-1278 Multi-Mode Data Controller unit offers seven modes of operation: Packet, ASCII RTTY, BAUDOT RTTY, CW, WEFAX, SSTV, and Contest Memory Keyer.

The RS-232C feature can be added to any IBM-PC or Apple II computer by installing the proper RS-232C I/O card (also called a *serial port, serial communications* card, or *asynchronous* card). For Commodore 64 and 128 machines, there are several devices on the market that plug into the *user* port at the rear of the computer.

A multi-function interface accessory is necessary for many applications. One such unit is *MFJ-1278 Multi-Mode Data Controller* (offered by MFJ Enterprises, Inc. PO Box 494, Mississippi State, MS 39762; 800-647-1800). That unit allows you to operate in seven modes: Packet, ASCII RTTY, BAUDOT RTTY, CW, WEFAX, SSTV, and Contest Memory Keyer.

Books

There are only a few books on the market that link computers and amateur radio. If you are interested in such literature, you might want to review *Microcomputers in Amateur Radio* (No 1305P), which retails at $10.95, and the *Packet Radio Handbook* (No 2722P), at $14.95. Both are published by TAB Books, Inc. (PO Box 40, Blue Ridge Summit, PA 17214).

In addition, Howard W. Sams & Co., Inc. (4300 West 62nd St., Indianapolis, IN 46268) offers my book *Commodore 64 & 128 Programs for Amateur Radio & Electronics* (No. 22516), $14.95. (The book and a diskette containing the programs are available from the author.)

Computers and EMI

One of the major drawbacks to interfacing some computers with amateur-radio equipment is electromagnetic interference (EMI)—commonly called "crud" and a few other more-colorful names. The clock and digital circuits within the computer, its switching power supply, and its TV monitor sweep and high-voltage circuits, generate harmonic-rich signals that interfere with receivers operating in the short-wave spectrum.

Fortunately, there are several things that can be done to eliminate the problem. For one, you could use a relatively EMI-quiet computer. I have found that the Commodore fits that description, while my IBM-PC is unusable around my Kenwood TS-430 transceiver. Another way to solve the problem is to use only shielded cables between the computer and its peripherals.

Finally, you can attempt to shield the computer and filter its supply line. Readers with expertise in that area are asked to write to me about their experiences. I'll pass the information on to your fellow enthusiasts.

Once again, we've run out of space. But in the meantime if you have any questions, suggestions, or comments pertaining to the amateur-radio hobby, write to Joe Carr, K4IPV, at PO Box 1099, Falls Church, VA 22041. ■

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CIRCUIT CIRCUS

By Charles D. Rakes

Electronic critter ridders

IMAGINE, THAT BIG THREE-DAY weekend has finally arrived, and you've labored long and hard to get things in tip-top shape for the events to come. The debris that has cluttered the backyard for all too long has been neatly packaged (the night before) and set out for pick-up by the sanitation department. Ah...all is right with the world (or so you thought). The morning before the big event (trash collection day), you open the front door to find that all of your efforts were for naught.

Neighborhood strays have chosen the sidewalk in front of your house as their restaurant, and made your neatly stacked refuse the main course. It's not that you mind their having wrangled a meal from your discards, but did they have to make such a mess?

This month, the Circus deals with a number of electronic "critter-ridder" circuits designed to electronically eradicate just about any uninvited diners. Now don't get the wrong idea, because I dearly love our animal friends, and wouldn't build a circuit to harm or mistreat a single one. But there are some places and times that man's best pal should be restricted from a given area.

For instance, if Mama's flower garden is in constant attack by your favorite pooch and you are getting all of the flack for Rover's tunneling, don't lose control and set steel traps or fire off a scatter gun. Instead, draw your soldering iron and build one of our circuits to "humanely" guide Rover out of Mama's hair, and restore peace and tranquility to your home.

Doggies aren't the only critters that these circuits are designed to move out; actually, just about any living creature with ears won't stay around for long in an area where one of the eradicator circuits is operating.

Audible Critter Chaser

Figure 1 shows the schematic diagram of the *Audible Critter Chaser*. The circuit is designed to flood an area with a continuous high-frequency tone to frighten away four-legged intruders. At the heart of the circuit is a 741 op-amp (U1) that's configured as a variable-pulsewidth, high-frequency audio oscillator. Potentiometer R8 (25K) sets the frequency of oscillation, while R9 (50K) sets the pulsewidth of the output signal that's used to drive transistor Q1.

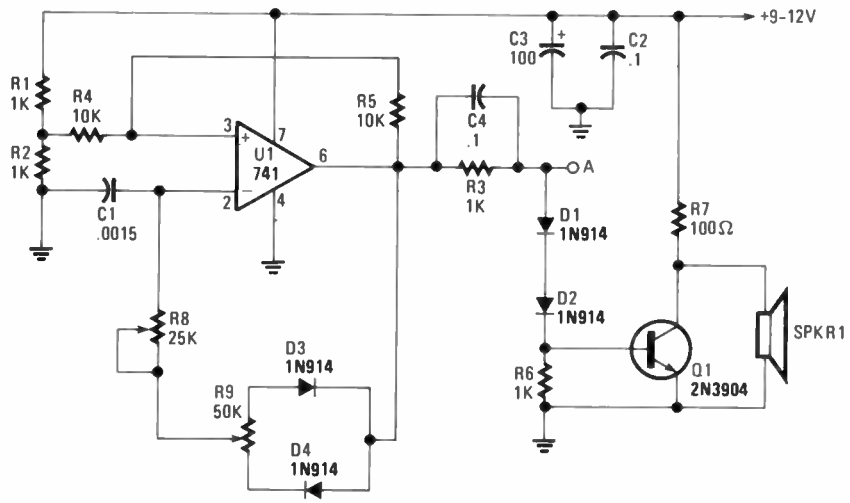

Fig. 1—The Audible Critter Chaser is designed to flood an area with a continuous high-frequency tone to frighten away four-legged intruders.

PARTS LIST FOR THE AUDIBLE CRITTER CHASER

U1—741 general-purpose op-amp, integrated circuit
Q1—2N3904 (2N2222 or similar) general-purpose NPN transistor
D1–D4—1N914 small-signal, silicon diode
C1—0.0015-μF, 100-WVDC mylar capacitor
C2, C4—0.1-μF, 100-WVDC mylar capacitor
C3—100-μF, 16-WVDC electrolytic capacitor
R1–R3, R6—1000-ohm, ¼-watt 5% resistor
R4, R5—10,000-ohm, ¼-watt 5% resistor
R7—100-ohm, ¼-watt 5% resistor
R8—25,000-ohm, potentiometer
R9—50,000-ohm, potentiometer
SPKR1—Piezo tweeter speaker
Perfboard material, enclosure, IC socket, 9 to 12-volt power source, wire, solder, hardware, etc.

Because the negative output swing of the 741 doesn't go completely to ground, D1 and D2 offer just the right amount of offset to allow Q1 to turn off during the negative portion of the oscillator's output signal. Resistor R3 sets the maximum drive current delivered to the base of Q1. Capacitor C4 functions as a speed-up capacitor to couple the high-frequency content of the drive pulse to the base of Q1, forcing it to turn on quickly. That keeps the efficiency high and Q1 cool.

The narrow output pulse, developed at the collector of Q1, is direct coupled to a high-output piezo tweeter, SPKR1. The output circuit is designed to drive an 8-ohm piezo speaker only. So don't blow the circuit by using a standard speaker with a voice coil.

There is nothing critical about the circuit, so it can be built on perfboard or a printed-circuit board. In either case, the use of an IC socket for U1 is recommended. A compact unit can be built by mounting the circuit and speaker in a plastic or metal enclosure, and obtain-

ing power from a wall plug-in 9- to 12-volt DC power supply.

When testing the Audible Critter Chaser, aim the piezo speaker away from the work area, or temporarily connect a 1000-ohm resistor in series with the speaker and the output. Set R8 to about mid position and turn R9 so that its wiper is at the cathode end of D4. That R9 setting produces the narrowest output pulse and the most-irritating sound with a minimum of current drain on the power source. Power up the circuit and play around with R8 and R9 to obtain the most-obnoxious sound that you can generate.

If you only want to irritate four-legged critters, then try reducing the value of C1 to one-half the value given in the Parts List, or try an even smaller value, and see how Rover responds to the near ultrasonic sound. The oscillator can be pushed beyond our own hearing range, while still producing enough output to drive most high-frequency sensitive critters away. Warning: Do not force an animal to stay in an area where the circuit is in operation! And always leave a clear and defined exit for their early departure. The animal may become frightened and confused, and in that state they can become very dangerous (even to their masters).

Control Oscillator

If a continuous irritating tone isn't enough, then add the low-frequency *Control Oscillator* circuit in Fig. 2 to the circuit in Fig. 1 to create a pulsating, mind-blocking, headache-producing chaser circuit that should remove even the most stubborn of intruders.

In the schematic diagram of Fig. 2, U2 (a 555 oscillator/timer) is configured as a low-frequency oscillator, with the off/on time (or duty cycle) equal to about one second each. The output of U2 at pin 3 is used to turn Q2 on and off at the rate of oscillation. The collector of Q2 can be connected to point "A" in Fig. 1 to turn the audio output of the circuit on and off.

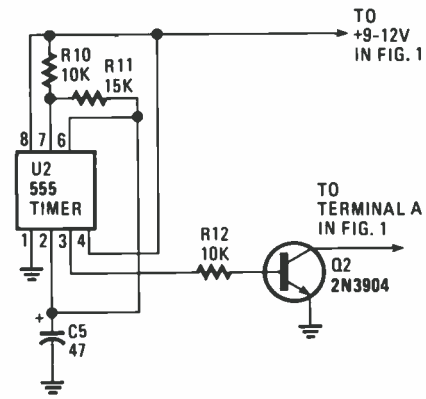

Fig. 2—The heart of the Control Oscillator is a 555 timer that's configured as a low-frequency oscillator whose output at pin 3 is used to turn Q1 on.

PARTS LIST FOR THE CONTROL OSCILLATOR

U2—555 oscillator/timer integrated circuit
Q2—2N3904 (2N2222 or similar) general-purpose NPN transistor
C5—47-µF, 16-WVDC electrolytic capacitor
R10, R12—10,000-ohm, ¼-watt 5% resistor
R11—15,000-ohm, ¼-watt 5% resistor
Perfboard material, enclosure, IC socket, wire, solder, hardware, etc.

The Control Oscillator's operation is simple. When Q2 (of Fig. 2) is tied to point A of the Chaser circuit (in Fig. 1), the Chaser circuit oscillates as designed, feeding its output signal to SPKR1 as long as Q2 (Fig. 2) is turned off. But when the output of the 555 swings positive, Q2 (Fig. 2) turns on and pulls the base Q1 (Fig. 1) low. That low turns off the output of the speaker. When the output of the 555 swings negative, Q2 (Fig. 2) turns off, allowing the output of the oscillator in Fig. 1 to be passed to the speaker.

To change the 555's frequency, experiment with the values of R10, R11, and C5. To lower the rate of oscillation, increase the values of those components; and to increase the rate, decrease their values. The duty cycle of the circuit can be varied by changing the values of R10 and R11.

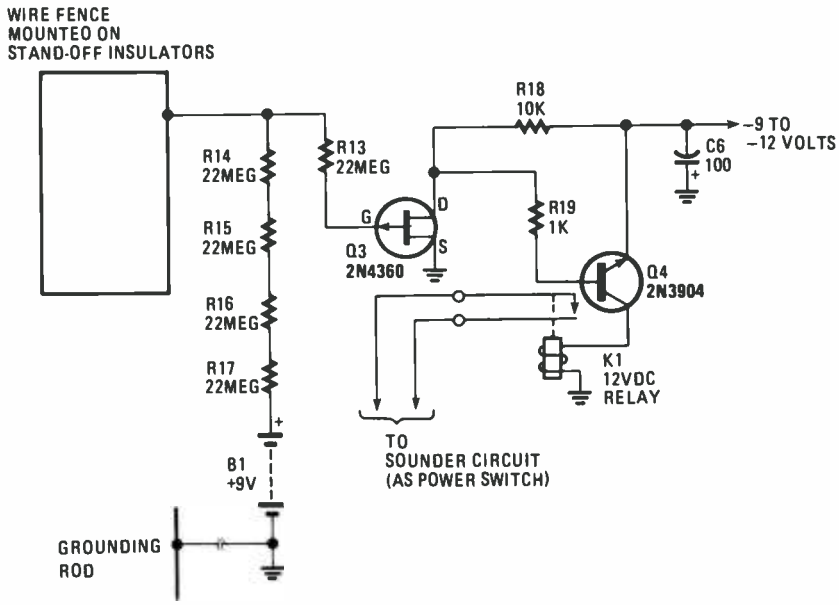

Fig. 3—The Automatic Switch uses a wire fence as a sensor, and a 12-volt relay to control the on/off operation of the Audible Critter Chaser.

Automatic Switch

Wouldn't it be great if the sounder circuit could be turned on automatically just when it is needed to drive out an intruder and not have it running all of the time? Wouldn't it also be nice if the sounder circuit could be used to protect a specified object or area outside? Fear not, because the circuit in Fig. 3, in conjunction with a fence, does just that.

The fence, which is used as a sensor, might be a bare wire around a small garden, shrub or special tree, or even the garbage barrel is connected to the input of the Automatic Switch. The relay (K1) contacts can be connected to the Audible Critter Chaser to turn on the sounder each time an intruder is detected.

As shown, five 22-megohm resistors are connected in series with a 9-volt bias battery, ground, and the gate of Q3 (a 2N4360 JFET). The fence sensor connects to the circuit at the junction of R13 and R14. The positive battery voltage fed through the five resistors keeps Q3 biased off.

As long as the fence wire is insulated from ground, transistor Q3 remains turned off, but when something touches the fence while in contact with the Earth (i.e., whenever something is grounding the fence), the bias is drained off through the intruder. That turns on transistor Q3, causing current to be drawn through R18. With the current flowing through R18, a base bias is supplied to transistor Q4, turning it on, which in turn causes the relay contacts to close, supplying power to the Audible Critter Chaser circuit.

The on time of the sensor circuit can be extended somewhat by connecting a 47-μF electrolytic capacitor across R18; the cap should be hooked up with the positive lead connected to the drain of Q3. That's a good area to experiment in to tailor the circuit to suit a specific need.

When installing the fence wire, be sure to use a good insulator at each tie point, and a ground rod to insure a good Earth ground system. If you happen to be close to a powerful radio station, a small capacitor might be needed between the gate of Q3 and ground. Stick with very small capacitors, say 5 to 39 picofarads. If the capacitor is made too large, the RC time constant will be too long for Q3 to respond to a fast moving intruder.

PARTS LIST FOR THE AUTOMATIC SWITCH

Q3—2N4360, P-channel JFET
Q4—2N3904 (2N2222 or similar) general-purpose NPN transistor
K1—500- to 1000-ohm, 12-volt DC relay
C6—100-μF, electrolytic capacitor
R13-R17—22-megohm, ¼-watt 5% resistor
R18—10,000-ohm, ¼-watt 5% resistor
R19—1000-ohm, ¼-watt 5% resistor
B1—9-volt transistor-radio battery
Perfboard material, enclosure, grounding rod, wire, solder, hardware, etc.

There are several other sensors that can be used to detect an intruder and turn on the Audible Critter Chaser circuit. An ultrasonic or IR motion detector can be used to activate the Chaser, or a mirror and IR light rope could be placed around a garden to trigger the sounder.

Pest Zapper

The circuit shown in Fig. 4—the *Pest Zapper*—is offered as a last resort to help get rid of the most stubborn of intruders. The heart of the circuit is a Model "T" coil, which can be found at auto salvage yards. (A Model "T" coil is an automobile ignition coil that differs slightly from those used in modern cars. Similar coils can be manufactured by placing a buzzer in series with the primary of the coil, and placing a capacitor across the buzzer to reduce any arcing.)

To conserve battery power, the "T" coil is turned on and off by a low-frequency UJT oscillator. Maximum battery drain occurs only when the SCR turns the coil on for a brief period of time. During the majority of the time, little current is taken from the power source.

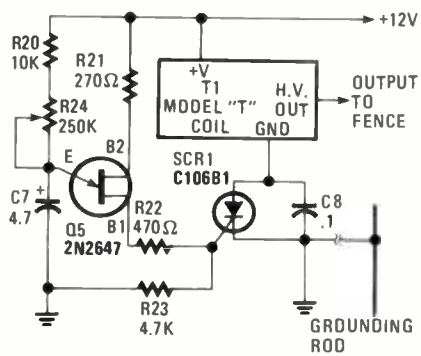

Fig. 4—The Pest Zapper is built around a model "T" coil. To conserve battery power, the coil is turned on and off by a UJT oscillator.

The operation of the Zapper is very simple. Components R20, R24, and C7 set the time interval for the UJT oscillator. The discharge path for the timing capacitor, C7, is through R22 and the gate-cathode junction of SCR1. The resistance of R22 sets the maximum gate current and also determines the SCR's on time. When experimenting with different values for R22 stay within the limits of 270 to 1000 ohms. The Pest Zapper can be used in conjunction with the Automatic Switch in Fig. 3 so that it turns on only as needed, or with the Control Oscillator for use in intermittent operation.

How about combining all four circuits, and adding a delay to the Pest Zapper, so that the circuit comes on only after prolonged contact with the sensor (fence), which would indicate that the Audible Critter Chaser has failed to accomplish its mission. There are all sort of possibilities. How many can you come up with?

PARTS LIST FOR THE PEST ZAPPER

Q5—2N2647 N-channel UJT
SCR1—C106B1 200-PIV, 3- to 6-A silicon-controlled rectifier (SCR)
C7—4.7-μF, 16-WVDC electrolytic capacitor
C8—0.1-μF, 100-WVDC mylar or ceramic disc capacitor
R20—10,000-ohm, ¼-watt 5% resistor
R21—270-ohm, ¼-watt 5% resistor
R22—470-ohm, ¼-watt 5% resistor
R23—4700-ohm, ¼-watt 5% resistor
R24—250,000-ohm, potentiometer
T1—Model "T" Ford spark coil
Perfboard material, enclosure, grounding rod, insulators, wire, solder, hardware, etc.

Until next month go forth and rid a critter electronically. ■

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DIGITAL VOICE RECORD/ PLAYBACK PROJECT

(Continued from page 65)

Then, if for some reason longer messages are required, they can be accommodated by closing the switch.

The sensitivity of the condenser microphone can be adjusted with the REC VOLUME potentiometer, RV2. Adjust RV2 so that the maximum input signal is available just prior to overloading the circuit. There's no meter or other indicator for that, so you'll have to use your ears as a "VU meter" for that. The VOLUME potentiometer, RV3, as its name indicates, controls the output signal to the loudspeaker.

If you connect the TWICE connector pin to the COM terminal, the message that is stored within the module is played twice each time the PLAY pushbutton switch is depressed.

The STOP switch, S3, can be used to terminate recording or playback.

Some Ideas

Now you have the built a basic Digital Voice Record/Playback Module that can record or deliver a short message, it's time to come up with some applications for the device. One gadget I plan to make is a telephone answer-only machine. That unit will answer the telephone at night after one ring, tell the caller to try again in the morning, and then hang up! (My sleep is important to me!) Such a device can also be put to good use answering unattended office telephones, perhaps providing business hours or other information to callers.

The module also will make an excellent voice alarm for an automobile theft-alarm system. Once the system is actuated, your voice will blare out from a PA loudspeaker hidden under the hood, calling for assistance from the police. The alarm can be configured to trigger the module at regular intervals, perhaps once a minute, with a conventional siren blasting in-between those messages.

Another idea would be to insert the module into a microphone line so that it will record selected segments of your comments. Later, those comments can be played back at the press of a button. Used that way, the device can be useful for paging an often-needed associate, or even in meeting situations. Just think, as a chairman of a meeting, you can call for order just by pressing a button. That'll save a lot of energy, on your part. ■

GRAYSCALER

(Continued from page 26)

computer's 9-pin RGB output connector. On the back is a phono jack to match the conventional coaxial or plain shielded cables used for composite monitors. Power is supplied through a small lead protruding from the Grayscaler's case. The lead has a small connector on the free end, which can be clipped to one of the *accessory/light-pen* pin terminals usually provided at the rear of a color-graphics card—the pin that supplies 5 volts to a light pen. The lead can be snaked into the cabinet through any convenient opening; just make certain that you connect it to the correct pin. Pin 5 is the one that you want; unfortunately, the pins aren't usually labeled. However, pin 2 is usually cut short to serve as a polarizing device for the light-pen connector. So if you know which pin is number 2, you know which are numbers 1, 3, 4, and 5. As a general rule, pin 5 is towards the bottom of the card; pin 1 is near the top: but the arrangement isn't standard: some cards have pin 5 near the top.

No Adjustments

The Grayscaler works without need for adjustments, utilities, or programming tricks. Simply plug it in to your computer's RGB port, connect the phono jack to your composite monitor, and run your software exactly as it was intended to be run. More often than not, the screen display will probably appear exactly the same as when you ran the monitor from the computer's color-composite output. You will notice a difference only when running software that creates a graphics display. Then the Grayscaler will provide a usable display.

The Grayscaler is available direct from Avocado Computer, 17352 Yorkshire Ave., Yorba Linda, CA 92686. The postpaid price (meaning all shipping and handling charges are included) is $62.95. For more information circle No. 82 on the Free Information Card. ■

"This isn't the mother ship! I told you we were riding the wrong beam in!"

ELLIS ON ANTIQUE RADIO

(Continued from page 85)

Without the set's schematic, I would never have known that the unit was supposed to be a 33K resistor. The color code was unreadable and—because of the overheating—the resistance had almost doubled (I measured it at 65K). I replaced that part with one of the proper value, making a mental note to check for overheating next time I turned on the set. Whatever circuit condition had caused the original overheating might still be a problem.

I also took a close look at the wiring for the two replacement electrolytic capacitors. It was very sloppily done, and such an excess of solder was used in making the joints that shorts to adjacent terminals were only narrowly avoided. I figured that if the wiring was so carelessly performed, it might be technically incorrect as well.

Here's how the set appears as we conclude this month's restoration work. The installation of a proper, "G"-type tube in the shield can behind the power transformer gives the grid wire enough clearance without pinching the can top.

Sure enough, checking the values of the replacements against those shown in the schematic, I found that a 16-μF section had been wired into a portion of the circuit where an 8-μF unit should have been and *vice-versa*. So I switched them around, changing the filter configuration back to the one intended by the set's designers. And, while I was at it, I cleaned up the joints to get rid of the excess solder.

As a final touch, I sprayed contact cleaner into the volume control, band switch, and tone-control switch; working all the controls back and forth to get the most effective cleaning action. That would minimize control noise and erratic effects caused by dirty contacts.

The Second Test Run

With the deep cleaning accomplished and all of the obvious problems corrected, it was time to make another test. When the radio warmed up, I was gratified to find that it picked up a full complement of broadcast stations without a trace of oscillation! And switching to one of the shortwave bands (formerly dead), I found it alive with signals. However, the tuning eye did not respond even when a strong signal was being received, and there was no reception at all on the second shortwave band. Those are problems that I'll try to have solved by next month, when we'll have another installment of the restoration project.

But the progress that's been made so far is an excellent example of what I consider to be one of the most important principles of antique-radio repair. Don't get serious about troubleshooting your radio until you've thoroughly cleaned and carefully examined it to uncover any components that have obviously failed; checked for any sloppy or incorrect repairs, or for any parts that were incorrectly installed by the previous owner(s).

Although it wasn't a problem with this particular set, the tube types should also be checked against the tube location chart to make sure that the correct type is in each socket. If your set doesn't have a tube chart, and you haven't been able to obtain service notes, remove each tube and look at the socket. The correct tube type may be marked on it.

Removing and replacing tubes (and other plug-in components) is a good idea for another reason. If contact between the pins and sockets have become impaired through oxidation and corrosion, the act of removal and replacement may reestablish it.

So by applying a little elbow grease to the set, and by using your powers of observation and a little common sense, you can take care of many problems that might otherwise be difficult to isolate and resolve.

Until Next We Meet

That's about all the space allotted to us this time around. But be sure to join us next month when we'll continue the Zenith restoration saga. Until then, please continue to send me your comments, questions, and stories! Write to Marc Ellis, C/O **Hands-on Electronics**, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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SOLID-STATE TESLA COIL

(Continued from page 40)

fahnestock clips are mounted to the board on ½-inch aluminum spacers, using #6-32 hardware. A 1¼-inch length of #12 solid-copper wire is fitted in one end of a 1¾-inch piece of dowel rod to produce the adjustable terminal of the spark gap. The other gap wire must be made from a #26 or smaller wire for the gap to perform properly.

Place the four dowel rods in the baseboard, position the 9-inch deck on top, and press down until all four dowel rods are even with the top of the circle. Connect the bottom of L1, using a short length of #12 wire, to the main grounding point (see Fig. 3). Also connect the bottom end of L2 to the same point.

A separate vertical ground rod can be positioned on the deck (see photos) for additional experimenting. The vertical ground was made from a 29-inch length of ¼-inch threaded rod, and covered with a section of aluminum tubing to give a neat appearance. At the top, a binding post was mounted for versatility. That allows the ground rod to accept a number of different experimental items.

Checking It Out

Before we start this stage of construction, a word of warning is in order:

Do not touch or make any adjustments while power is applied to the Solid-State Tesla Coil. Remember that you'll be dealing with high voltages, so caution is the watchword.

With the power off, set the spark gap for a ⅛-inch gap and connect the tap clip to turn 15 or 16. Plug in the power cord and turn S1 on. A loud electrical discharge should be heard, and a blue brush discharge should be seen at the top of the pointed screw that's connected to L2.

Turn the power off and move the tap wire (that's connected to L1) up or down one turn at a time until the greatest blue discharge is obtained at the top of L2. Form a 1½ to a 2-inch vertical gap between the ground rod and the top of the coil to aid in tuning up the coil. When the Tesla coil is properly adjusted, it should produce a 2-inch arc between the top of L2 and the ground terminal.

The coil discharge is most dramatic in a darkened room, and you should be able to light a fluorescent lamp at a distance of about two feet from the secondary coil. A clear incandescent lamp moved to within a few inches of the secondary coil will produce a beautiful blue lightning array from the lamp's filament to the outer edge of the glass envelope. Neon lamps glow around the coil without wires. Experimenting with the coil can be an almost endless adventure. But remember, always put safety first! ■

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(Continued from page 27)

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A fused DC-power cable, telescopic whip antenna, mobile mounting bracket and hardware, and an AC-to-DC converter are included with the Model AR160, for its suggested retail price of $189.00. It is manufactured by **AOR, Ltd.** of Japan, and is available from their wholly-owned subsidiary, Ace Communications, Monitor Division, 1707 East 106th Street, Indianapolis, IN 46256.

Probe Switch

The *Philips PM 2195 Probe Switch* is designed to eliminate the load and interference problems normally associated with switching waveforms before the signal is applied to the input probe. That allows signals to be switched between the probe and the oscilloscope input in typical GPIB systems, without significant degradation of bandwidth.

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The PM 2195 and PM 2125 are part of the Philips System 21 line of switching and I/O modules. Based on a building-block concept, modules can be purchased as needed and reconfigured to accommodate future applications. Modules can be connected by snapping them together, or with cables.

The PM 2195 Probe Switch is priced at $650.00, and the PM 2125 Probe Switch Driver is $450.00. For further information, contact John Fluke Mfg. Co., Inc., P. O. Box C9090, Everett, WA 98206; Tel. 800-443-5853. ■

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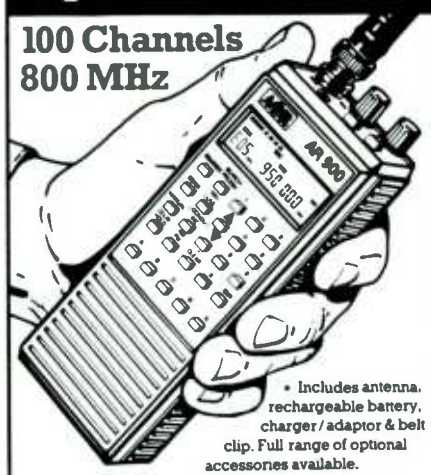

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Free Information No.		Page
6	AMC Sales	25
22	Ace Communications	103
5	All Electronics	13
—	Amazing Devices	27
—	Antique Electronic Supply	104
8	CIE	11
19	Chemtronics	25
—	Command Productions	103
10	Cook's Institute	101
11	Digi-Key	CV2
23	Electronic Parts Outlet	93
—	Electronic Tech. Today	8, 14, 28
—	Electronic Tech. Today	100, CV3
—	Electronics Book Club	3
20	Emco	95
21	Hal-Tronix	95
9	Halted Specialties	13
—	Hands-on Bookstore	102
18	JDR Microdevices	6
12	Jensen Tools	23
14	MCM Electronics	17
16	Mark V Electronics	23
—	McGraw Hill (C.E.D)	91
—	Midwest Electronics	105
13	Mouser	101
—	NRI	21
—	Pacific Cable	15
7	PanaVise	5
17	The Datak Corporation	27

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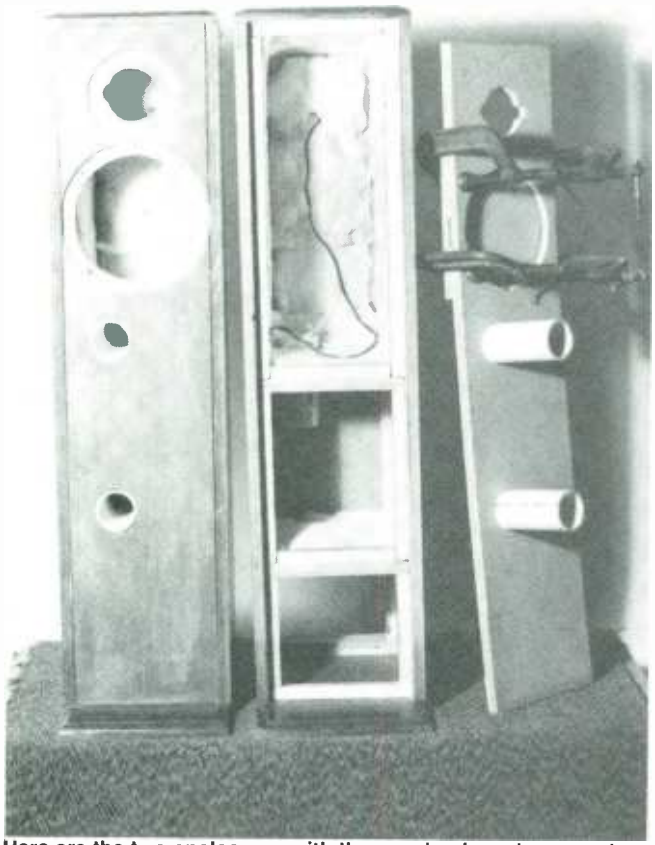
TOWER SPEAKERS

(Continued from page 46)

foam or felt damping material in the recess between the tweeter frame and the ¼-inch plywood faceplate.



Here are the two enclosures with the speaker board removed from one to show its' internal construction. The board clamped over the woofer hole protects the speaker panel from breaking during work on the enclosures.

Woofer Mounting

If you're unsure of the woofer's polarity, test the it by connecting a 1.5-volt battery to the woofer terminals. Mark the terminal connected to the positive pole of the battery if the cone moves outward upon contact. Mark the other terminal if the cone sinks backward into the cabinet. The mark identifies the positive speaker terminal.

At this time it is a good idea to temporarily mount the woofer, using foam weather stripping instead of sealer. Apply the weather stripping around the cut-out, and connect the speaker cable (being mindful of the polarity), but don't solder. Install the woofer by threading the ⅛-inch bolts into the T-nuts you've inserted into the back of the speaker board. The temporary mounting permits you to make further changes in box damping or wiring, if necessary.

Leave the cabinet in the reclining position until the silicone rubber behind the driver has set.

Adjustment

Connect your new speakers to an amplifier or receiver, and test them at low volume. Rotate the L-pad shaft to see that it controls the tweeter output correctly. Then adjust it to the point that makes the sound from the woofer and tweeter blend into one voice.

You should find that your towers perform well with any kind of music. If you want to hear how they reproduce unusual sound effects, try them with the Pink Floyd disc of *Dark Side of the Moon*. Their clarity of sound with that recording is startling at times.

If you hear any coloration, remove the woofer and rearrange the Fibreglas damping material. Or add some loose polyester batting behind the woofer.

When you are satisfied with the sound, remove the woofer and solder the connections to it. Once again lay the entire unit down. Remove the foam weather stripping around the woofer cut-out and apply a ring of silicone rubber sealer. If you don't want to replace the mounting bolts, fill the bolt holes with sealer. Set the woofer down, twist it a bit for better sealing, and leave it until the sealer has set.

Your towers are now ready to play and play. ■

GRAVITY OF THINGS

(Continued from page 17)

"Others have found irregular variations in gravity during experiments conducted in mine shafts, but their results remain inconclusive because the density of the rock near the mines is not adequately known, which would affect their measurements. "Since the density of ice is well known, our experiment will be much more accurate than any previous geophysical measurements of gravity. Basically, we are taking advantage of the ice as a medium for the instrument to travel through. It has a known density, unlike the inhomogeneous rock materials in mine shafts or unlike air, which doesn't have a density high enough for the type of measurements we are making", Zumberge said.

The researchers believe they will be able to measure the gravitational constant to better than 1 part in 1,000 over depths of about 300 to 5,000 feet down the borehole.

To assure optimum accuracy, the one-half inch steel cable that will be used to lower the gravity meter into the borehole, will be lowered into the Consolidated Silver Mine in Idaho in late June to record its absolute length. The gravity meters will be calibrated in Alaska at the same latitude as the test site in Greenland. At the test site, a gravity survey will be conducted of the region surrounding the borehole and radar soundings will be used to map the structure of the ice and the underlying bedrock.

"This experiment could have a profound effect on our understanding of the physical universe," said Ander. "There are not many opportunities for geophysics to make a fundamental contribution to pure physics, but this is certainly one of them." ■

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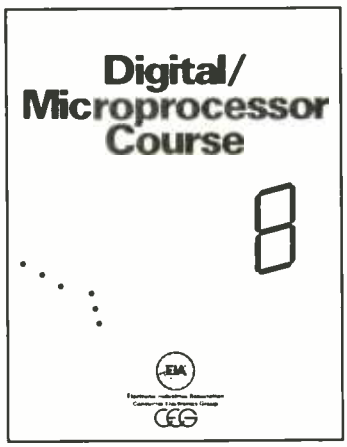
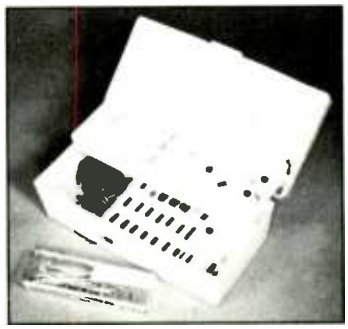
The members of the Electronic Industries Association Consumer Electronics Group (EIA/CEG) through the Product Services Committee, has marketed the illustrated parts kit for vocational schools, educators and technicians. This is the same material used in the Digital and Microprocessor Course during EIA's summer workshop programs. These workshops are organized by the Consumer Electronics Group and co-sponsored by national service organizations and state departments of vocational education.





Parts and components are contained in a lightweight tool box with individual compartments. It includes a breadboard, power supply, pre-dressed jumpers, resistors, capacitors, and integrated circuits to perform all digital exercises 1 through 25 of the Digital/Microprocessor course book listed in the table of contents. Some parts have been included for the microprocessor section but other components will have to be acquired (as listed in the Introduction to Exercises 26–31).

Individual and classroom size quantities are available at the following cost: quantities 1–9, $69.95 each, quantities 10–19, $67.95 each, and for quantities 20 or more, $64.95 each (cost includes shipping and handling). The kits will also include the Digital and Microprocessor Course book. Additional books are available at the cost of $2.00 per copy.

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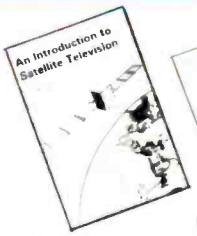

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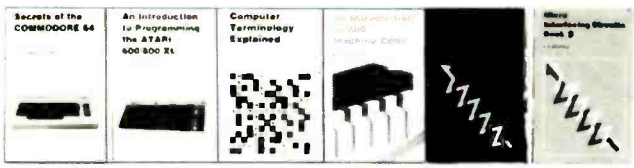

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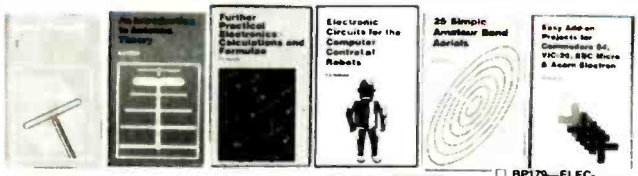

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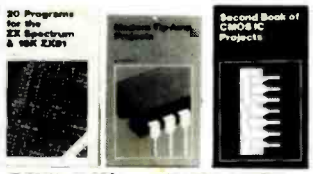

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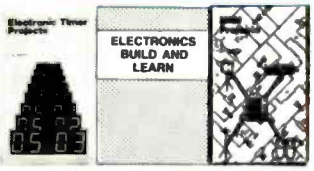

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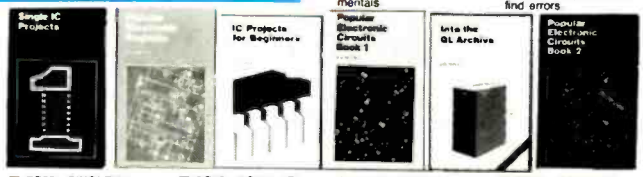

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