# HARDWARE HACKER

## Is dowsing for real? Fundamental research tools can lead you to an answer.

**DON LANCASTER**

Just after last month's column deadline, I managed to find a real nice tutorial on solitons. See Russell Herman's *Solitary Waves* in the July-August 1992 issue of the *American Scientist*. I also came across another neat property of solitons: If two ordinary waves crash into each other, they'll self-destruct. But if two solitons crash into each other, they'll pass right through each other without any damage!

### Fundamentals of research

One recent helpline caller became rather upset when I told him I did not believe in dowsing. His main point was that if you can buy dowsing rods at *Northern Hydraulics*, that confirms it right there. Doesn't it? Well, not necessarily.

Dowsing clearly meets my "looks like a duck and quacks like a duck" pseudoscience definition. It is certainly reasonable to approach any pseudoscience topic with a lot of skepticism.

On the other hand, it is not fair to categorically dismiss something out of hand you know little about. So, to be fair about this, I decided to feature dowsing for this month's resource sidebar, and let you decide this yourself. Actually, I needed an excuse to describe the major research tools that I use. Dowsing is as good a topic as any to research.

There are three types of research, *primary*, *secondary*, and, *tertiary*. Primary research is that research which you do personally. It can often be the best research of all provided, of course, that you keep any bias in check, use reasonable tools and methods, and don't get in over your head.

Secondary research requires study of the published literature. The quality of secondary research depends on how thorough you are, the references you cite, and the overall credibility and competence of the references.

Other less polite names for tertiary research include *anecdotal evidence*, *hearsay*, *mythology*, *hype*, *hoaxes*, *scams*, *wishful thinking*, *urban lore*, *hidden variables*, *blind faith*, or simply plain old outright *lying*.

Now, it is not fair to assert that tertiary research will always be dead wrong. But it is fair to say that tertiary research quality will nearly always be very low and highly suspect. You'll need a lot more of it to prove a point—an *awful* lot more. At the very least, *multiple and independent* sources are absolutely essential. All extraordinary claims *demand* extraordinary evidence.

Let me show you how both primary and secondary research helps me answer this question of great importance.

### Is dowsing for real?

My primary research experience with dowsing is fairly limited. Years ago, I was given some dowsing rods to play with. I could not get them to work. People I loaned them to who claimed they "believed" could not get them to work either. I have seen employees of my local water utility routinely using dowsing rods. I think I know one reason why my utility bills are so high.

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**CANON "EX" CARTRIDGE RAPID RECHARGE**

NOTE: Use this method only on a cartridge having a good drum and lots of extra room remaining in the spent toner tank. You can usually get three or four refills before the spent toner tank overflows. Drum permitting.

1– Set the EX cartridge on its end, top away from you, such that the serial number is up and the "Made in Japan" is down.

2– Using a large screwdriver, pop open and remove the large white toner filling cap. Set this cap aside.
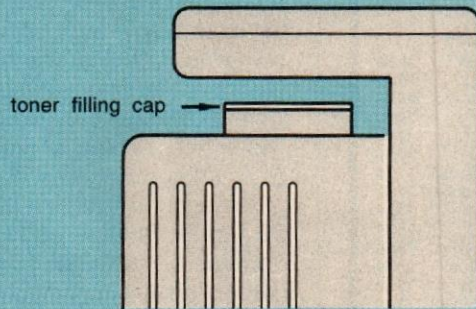


toner filling cap ➛

3– Pour in a bottle of EX toner, using a bottle with a flexible filling snout. Replace the toner filling cap.

4– Carefully vacuum any remaining loose toner and wipe everything with a soft and clean cloth. Run a dozen test pages that alternate white and black sheets to test your work.

**FIG. 1—THE "RAPID RECHARGE" METHOD for an EX laser cartridge refill.**

I am a caver, and most cavers will aggressively use any tools they can to find new caves. In all of caverdom, not once have I ever seen or heard of anyone successfully dowsing caves—at least not firsthand.

On to some secondary research. First, you should try to find some dowsers. Start with the *Encyclopedia of Associations*, and you'll find a listing of the 3500-member *American Society of Dowsers* which also publishes *American Dowser* magazine. You'll find that *Borderlands Research* and the *Society for the Application of Free Energy* also sometimes have a strong dowsing focus.

The *Skeptical Enquirer* is bound to have touched on this at one time or another. And *Rex Research* has one or two of his *Infolios* that provide some dowsing information.

By far my favorite research tool is *Ulricht's Periodicals Dictionary*. But in its listing of more than 600 magazines on water resources, the *only* one of interest is *American Dowser*.

The *Divining Rod* entry is a good example of what researchers call a *false hit*.

The *Thomas Registry of Manufacturers* is of no help at all, because none of the manufacturers listed will admit to providing any dowsing supplies. *Northern Hydraulics* does carry rods as stock No. 15554-384. *American Dowser* should list other sources of supply.

*Books in Print* lists no titles under the subject of *dowsing*, but it suggests that you refer to *divining* or to *radioesthesia* instead; there you'll find several dozen titles. I've picked some of these for our listing.

By the way, one of the really big problems in doing any research is getting your key words right. More often than not, the insiders will be calling things by different names. *It is of utmost importance to find these "correct" names as early in the game as you possibly can.*

The ultimate heavy weapon in any research work is usually the *Dialog Information Service* now offered on *GEnie* 24 hours a day. There are about a half *billion* abstracts on line. Last month, I was overwhelmed when a search for soliton information produced around 8,300 references. How many dowsing references do you suppose they now have on line?

Would you believe *seven*?

Yup. As near as I can tell, there has been darn little serious dowsing research *ever* done. But three of the papers are quite interesting.

The first is a Utah study in which a powerful correlation was observed between a big group of dowsers and *something*. The study points out emphatically that the researchers were totally unable to correlate that "something" to either ground water or its related magnetic fields.

The second interesting paper describes a British study in which dowsers were invited to find a big hidden flowing-water pipe. While "something" was apparently happening, the dowsers were unable to find the pipe reliably. Perhaps more telling, professional dowsers did no better than amateurs.

The third interesting paper is a careful analysis of a pendulum. When any pendulum is driven near its resonance frequency, there is an expected normal physical reason why a pendulum will suddenly start bobbing around. This is explained by the underlying math of driven oscillators. No further external cause of any type is needed. No, you don't even have to invoke chaos or nonlinear coupling effects.

And that's about as far as I got with secondary research. The next step would be a thorough study of the books, back issues of the publications, and attempts to contact the authors of the key papers. Very often, the *Science Citations Index* can let you find an older paper and see who references it. This magic directory is one of the few resources that can let you move *forward* through time, gaining *new* material as it is published.

If you have anything useful to add to all this, send it to me. I'll send you a free copy of my *Incredible Secret Money Machine II* book for your trouble.

## PostScript review

I just received a reader letter that was full of dead-wrong misconceptions about the PostScript language. So I think a review of the fundamentals is once again in order.

I really like PostScript because it is an ideal Hacker's general purpose computing language. It is also superb for the fast and device-independent electronic distribution of high quality technical information in a new *Hacker Data Format*.

I use PostScript for everything as my primary language. "Everything" includes engineering design, fractals, stock market analysis, printed-circuit layouts, video compression, fuzzy data fitting, hot-tub controllers, fancy numeric analysis, exotic half-toning, wavelet studies, and direct dedicated homebrew CAD/CAM control. I also use PostScript to create everything you see here and in my other columns.

You can talk to PostScript with ordinary text files from any old word processor or editor. Or you can let fancy application packages write the code for you. PostScript is one of the easiest-to-use languages I have ever seen. The more you play around with it, the more powerful it becomes.

PostScript is definitely a general-

## NAMES AND NUMBERS

**Adobe Systems**
PO Box 7900
Mountain View, CA 94039
(800) 833-6687

**American Scientist**
Box 13975
Research Triangle, NC 27709
(919) 549-0097

**Appliance Service News**
PO Box 789
Lombard, IL 60148
(708) 932-9550

**The Bell Jar**
35 Windsor Drive
Amherst, NH 03031
(603) 429-0948

**Robert Bosch**
38000 Hills Tech Drive
Farmington Hills, MI 48331
(313) 553-9000

**Computer Hot Line**
15400 Knoll Trail Drive, #500
Dallas, TX 75248
(800) 999-5131

**Deep Vision 3-D**
6457 Santa Monica Blvd
PO Box 38386
Hollywood, CA 90038

**Dialog**
3460 Hillview Avenue
Palo Alto, CA 94304
(415) 858-2700

**Digital Video**
80 Elm Street
Peterborough, NH 03458
(800) 441-4403

**GEnie**
401 N Washington St
Rockville, MD 20850
(800) 638-9636

**Global Micro-Parts Depot**
11151 Denton Drive
Dallas, TX 75229
(800) 325-8488

**Magnets in Your Future**
PO Box 250
Ash Flat, AR 72513
(501) 856-3877

**NewTek**
215 SE 8th Avenue
Topeka, KS 66603
(800) 765-3406

**Northern Hydraulics**
PO Box 1499
Burnsville, MN 55337
(800) 533-5545

**Radio World**
5827 Columbia Pike #310
Falls Church, VA 22041
(703) 998-7600

**Recharger**
3340 Sunrise Avenue #102
Las Vegas, NV 89101
(702) 438-5557

**SAE**
400 Commonwealth Drive
Warrendale, PA 15096
(412) 776-4841

**Science Resources**
1260 Liberty Way, Ste B
Vista, CA 92083
(619) 727-6933

**Service News**
38 Lafayette Street
Yarmouth, ME 04096
(207) 846-0600

**Synergetics**
PO Box 809
Thatcher, AZ 85552
(602) 428-4073

**Tapeswitch**
100 Schmitt Blvd
Farmingdale, NY 11735
(516) 694-6312

**Don Thompson**
6 Morgan #112
Irvine, CA 92718
(714) 855-3838

purpose computer language. All of the required language features and constructs are in place. As with any general-purpose computer language, there are strengths and weaknesses. PostScript does certain jobs better than C++ and C++ does some tasks better than PostScript. PostScript's massive strengths lie in its ability to fill up otherwise clean sheets of paper with stunning mixed text graphic and text layouts—especially those that need lots of transforms or bunches of computation.

*Nothing* even remotely compares with PostScript. Its big weakness lies in its ability to interact with the outside world. PostScript is often limited to marking up sheets of pa-
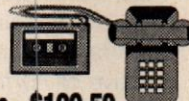
per, writing files to disk, returning information over any communications channel, or sending out commands to external devices.

Absolute proof that PostScript is a general-purpose computer language is found in the PSRT Round-Table on *GEnie*. Of the more than 1000 files in the library, many use PostScript for totally non-graphical, general-purpose computing needs. They also use extensive computations combined with only an incidental graphic output.

PostScipt is an example of a stack- and dictionary-oriented, extensible, threaded, interpretive, and reentrant language. It is a distant relative of *Forth*.

Important features of PostScript include its total device- and resolution-independence, and its ability to draw graceful curves and work with sparse data descriptions.

Yes, you can get a low cost PostScript host interpreter. The most popular one is known as *GhostScript*, and is available for the downloading from many BBS sources, including the GEnie PSRT. GhostScript provides on-screen previewing on *any* host platform. Full source code is available, again by downloading.

Other host PostScript interpreters include various forms of Adobe's CSPI, an acronym for a *Configurable Software PostScript Interpreter*. There are now dozens of other third-party interpreters available.

PostScript works best when it is inside a dedicated computer that is designed from the ground up to meet its needs. Most of these dedicated PostScript computers usually have an obscenely misleading and a horribly restrictive label placed on them. These awful labels say "printer" on them.

Instead, I prefer to call all of those HUCC's, which is short for *Hacker's Universal Coprocessing Computer*. I believe that PostScript provides the most outstanding emerging opportunities for *Electronics Now* readers today.

For instance, I'll routinely use the 68030, the twelve megabytes of RAM, and the hundred megabyte hard drive of my *LaserWriter* Pro630 HUCC as a fine "mother's

little helper" coprocessor for the 6502 in my Apple IIe. It lets me explore non-obvious subjects powerfully and profitably in non-traditional ways.

PostScript can be compiled easily. The simplest example is the PS *bind* operator. An intermediate example is PostScript's *binary object format*. Some highly profound compiling takes advantage of PostScript's *form* capabilities. A cached form can dramatically im-

prove runtime speed.

External compilers are also available that greatly improve the efficiency and speed of runtime code. Examples of these include Adobe's *Distillery* and *Acrobat Distillery*, or my *Maudedoc* and *Triple Distilling* techniques.

Yes, PostScript is strongly object-oriented. But only if you want it to be. The crucial keys to an object-oriented language are modules that have a single input, one output, and

## DOWSING RESOURCES
### Associations:

**American Society of Dowsers**
Brainerd Street Box 24
Danville, VT 05828
(802) 881-7165

**Borderland Sciences**
Box 429
Garberville, CA 95440
(707) 986-7211

**Free Energy Application Society**
1315 Apple Avenue
Silver Spring, MD 20910
(301) 587-8686

**KeelyNet BBS**
Box 1031
Mesquite, TX 75149
(214) 324-3501 (BBS)

**Rex Research**
Robert Nelson
Box 19250
Jean, NV, 89109

**Skeptical Enquirer**
Box 703
Buffalo, NY 14226
(716) 636-1425

### Books:

William Barrett
*Divining Rod*
Carrol pub
University Books, 1967

Gabriele Blackburn
*Science & Art of the Pendulum*
Idylwild Books, 1984

Bill Cox
*Techniques of Swing-Rod Dowsing*
Life Understanding, 1971

R. Davies
*Dowsing: The Art of Finding Hidden Things*
Aquarian Press, 1979

Harvey Howells
*Dowsing for Everyone*
Viking Penguin, 1979

R. Simmons
*Professional's Complete Dowsing Course*
Dowsing Institute, 1978

Robert Steffy
*The Dowser's Primer*
Halldin Publishers, 1980

Evon Vogt
*Water Watching USA*
University Chicago Press, 1979

### Critical papers:

F.E. Irons
*Concerning the nonlinear behaviour of the forced spherical pendulum*
European Journal of Physics
vol.11, no.2, p.107-15, March 1990

B. Walti & U. Jenzer
*Dowsing and electromagnetic fields*
Bulletin de l'Association Suisse des Electriciens
v.75, #15 p.903-6, 4 Aug. 1984

Ian Killip
*Geophysical dowsing*
Civil Engineering for Practicing Engineers
vol 4, n 4, p 343-360, Apr 1985

O. Vyzkumu
*Proceedings of the Conference on Psychotronic Research*
Joint Publications Research Service
Arlington, VA, 227p, 6 Sep 74

Duane G. Chadwick
*The Detection of Magnetic Fields Caused by Groundwater and the Correlation of Such Fields with Water Dowsing*
Utah Water Research Lab, Jan 71

that perform one well-defined task—otherwise known as a PostScript procedure inside a PS dictionary.

Study any Acrobat output for examples of PostScript object use or investigate PostScript's *execuser-object* and its related commands.

For more on PostScript, start with Adobe's red and blue books. Then look at my files STARTUP.PS and SPEEDUP.PS on *GEnie* PSRT or write or call for more help.

## Toner-cartridge reloading

Brand new toner cartridges for popular laser printers might cost as much as $140 each. You can easily refill toner cartridges several times at a cost as low as $4.25, and you can do it in a minute or two.

The primary reason for cartridge refilling is economics. New cartridges yield toner costs of around a nickel per printed page—which is much higher than jiffy printing. Recycled cartridges yield toner costs as low as 0.1 cent per page. That's a 50:1 cost reduction which can completely blow away old line printing. It also makes book-on-demand publishing quite attractive.

Refill toner can also be better than the factory original material. It can give you such options as blacker graphics, longer cartridge life, color, check-printing MICR magnetics, or thermal dye-sublimation for T-shirt printing.

A typical toner cartridge includes a *fresh toner tank*, the *magnetic feed roller*, a *photosensitive drum*, and a *spent toner holding tank*.

In general, there are many reasons why a toner cartridge fails. The most common is that it simply runs out of toner. A plain old quick refill takes care of this problem.

The second most common problem is caused by drum defects. Factory drums seem to be designed to fail shortly after one tank of toner is used. They might drop in sensitivity, or pick up scratches or dropouts. There's now a lively third-party *hard coated drum* industry today. Swapping to one of these hard drums can let your cartridge be recycled dozens of times.

The third most common cartridge problem is holding tank overflow. This typically will happen after three

or four refills of the newer cartridges. The obvious preventive step is to empty the tank before it overflows. Recycling the recovered spent toner is *not* recommended.

I have shown how to recycle the older *Canon* CX, SX, and LX carts in previous columns. The step-by-step details also appear in the *Hardware Hacker II*, my *Intro to PostScript* video, and on *GEnie* PSRT.

This month I will tell you how to recycle the popular *Canon* EX cartridge that is used on such machines as the *Hewlett-Packard* LaserJet 4M+ or in the *Apple* LaserWriter Pro630. This EX cart is much easier to recycle than the earlier cartridge.

There are two recycling methods that I'll explain here. The *Rapid Recharge* method of Fig. 1 just adds toner. Pop the cap, pour in the toner, and replace the cap. This works *only* if the drum is still in good condition and the spent toner tank is far from full. You can make up a special flexible snout refill bottle to make it easi-

er to put the toner into the tank. A length of heat-shrink tubing works fine.

The *Total Teardown* recharge of Fig. 2 takes longer, but it can fix most cartridge problems. On the other hand, it can cause more problems than it solves—stripped screws, dropped parts, loose wipers, fingerprinted or light-flashed drums. It can easily *raise* your per-page toner costs.

Removing two screws separates the EX cartridge into two pieces. The toner-tank half can be refilled by the rapid recharge method. Two other screws can be removed to provide access to the entire bottom of the tank. Mixing brands of toner is *not* a good idea.

You can install a new hard-coated drum in the other half cartridge. Try to avoid getting fingerprints or scratches on it or exposing it to strong light. The spent toner tank is also on this half. Removing two screws gives you access to the bottom of the tank.

Cartridge recycling is best done outdoors or in a hooded area with a vacuum cleaner available. A face mask is recommended.

By the way, it pays to monitor and label the history of each cart carefully. I use brand new cartriges only for my camera-ready art. Prime recycled cartridges are used for my book-on-demand production and catalogs. I use problem cartriges for in-house work.

If you start up your own cartridge recycling service, one key rule is to a seven mile service limit just like pizza delivery: Go beyond seven miles and the pizza gets cold, and you will get into big arguments over the anchovies. As soon as you advance to commercial shipments and unknown sources and histories of carts, your problems will increase and your profits will go down. So will your customer satisfaction.

Be sure to hand carry all your carts to your customers. Each customer should get his own cart back, each and every time. In some markets, you can charge as much as $15 to $19 for a cartridge refill.

Several big printer suppliers offer "recycling" programs. This is really a blatant attempt to *prevent* personal or third-party cartridge recycling. It is ecopornography at its very worst. If you ever get a prepaid recycling pack from any printer supplier, put a brick in it and send it back.

The leading trade journal for the toner recycling industry is *Recharger* magazine. You will find lots of ads for the toner, drums, tools, and services in it. This industry has matured, with many outfits now offering first quality products. But there still are some scams and flakes on the fringe, so always check on the reliability of a supplier before you lose a lot of money.

### CANON "EX" TOTAL TEARDOWN CARTRIDGE RECHARGE

1 – Set the EX cartridge right side up on a cloth surface in an area where toner dust can be safely managed.

2 – Use a Phillips screwdriver to remove the screws holding the cartridge retainer dogs in place. Squeezing the cartridge frees the dogs. Set these plastic dogs, the screws, and their springs aside. Separate the cartridge halves.

remove screw    remove screw
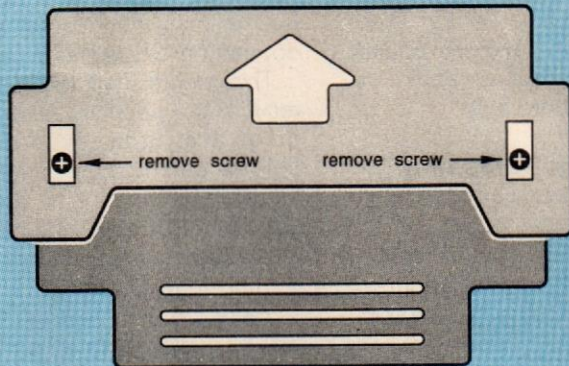
3 – Carefully set the fresh toner tank half aside. Observe the photo drum retainer bracket on the right side of the spent toner tank half. Remove the two Phillips screws and this bracket. Then carefully remove the photo drum and set it on a soft cloth. Avoid any fingerprints or exposure to strong sunlight.

remove screw
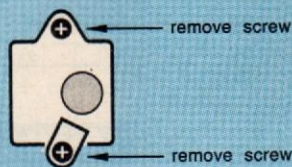
remove screw

4 – Snap the gray cylindical charging roller out of its holders. Wipe it carefully with a slightly dampened soft cloth to restore its light gray color. Set this charging roller aside.

5 – Remove the two Phillips screws securing the spent toner wiper blade. Remove the wiper blade and set it aside. Carefully vacuum or dump any toner in the spent toner tank. Reuse of this toner is not recommended.

remove screw    remove screw

6 – Carefully clean the wiper blade with a soft cloth. Replace the wiper blade assembly and its two Phillips screws.
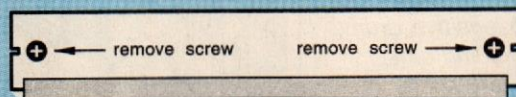
7 – Snap the toner charging roller back in place. Inspect the old photo drum for scratches while carefully cleaning it with a soft cloth. If you are substituting a new hard drum, do so at this time. Inspect and clean the photo drum retainer bracket. Replace drum, retainer bracket, and two Phillips screws.

**FIG. 2—THE "TOTAL TEARDOWN" METHOD for an EX laser cartridge refill.**

It does *not* pay to buy toner in bulk unless you are recycling over 2000 cartridges per month. Use the refill bottles instead.

A superb source for laser printer repair and maintenance training is *Don Thompson*, who now offers his seminars worldwide. He also provides low-cost replacement parts and modules.

8– Remove the two Phillips scews on the end cap of the fresh toner tank half. Very gently remove this end cap, making sure that none of the three internal gears pop off their posts. Vacuum the gears if needed.

remove screw →
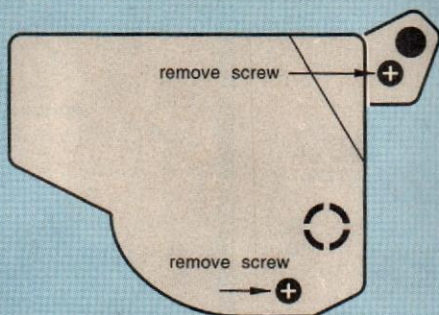
remove screw →

9– Flip up the white lever holding the magnetic pickup roller in place. Carefully remove the magnetic pickup roller. Vacuum it and gently wipe it with a soft cloth. Snap the end cap back in place (without screws) to retain the gears.

10– Make a fixture (such as a cardboard box with a rectangular hole in it) that lets you firmly support this module so that the black magnetic transfer roller area sits horizontally on top.

11– Remove the two Phillips screws holding the fresh toner wiper blade. Remove the wiper blade, and carefully clean it with a soft cloth.

← remove screw      remove screw →
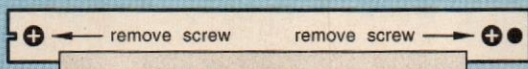
12– If you are changing brands of toner, remove any remaining old toner. Then carefully pour a new bottle of toner into the exposed toner tank. Level the fresh toner as you pour it. Wear a face mask.

13– Replace the fresh toner wiper blade and its two Phillips screws. Carefully remove the end cap. Make sure the gears are all free to rotate. Inspect and clean the magnetic transfer roller supports and snap the roller back into place. Replace the end cap and its two Phillips screws.

14– Note how the two hinge pins hold the two cartridge halves together. Insert the cartridge halves together, squeeze them slightly, and replace the cartridge retainer dogs. Replace the final two Phillips screws.

15– Carefully vacuum any remaining loose toner. Run a dozen test pages that alternate white and black sheets to test your work.

THE "TOTAL TEARDOWN" METHOD continued.

## New tech lit

The Society of Automotive Engineers (SAE) is now offering the third edition of the 840-page Robert Bosch classic Automotive Handbook. It costs $29 for nonmembers, and includes new coverage of sensors, driver information systems, and GPS navigation.

NewTek has just introduced a stunning new, nonlinear video-editing system it calls a Video Flyer. It uses hard disks instead of videotape to give you random video access. The Video Flyer eliminates most of the overpriced junk previously associated with serious video post-production. It offers broadcast quality that is free of any generation loss. Demonstration videos are offered.

The Bell Jar newsletter continues to offer exceptional information for those interested in high-vacuum techniques. A recent issue shows how to build your own scanning-electron microscope.

Speaking of vacuum concepts, new make-your-own vacuum tube kits are offered by George Schmermund of Science Resources. After you build your own vacuum tube triode, you put it to work in a regenerative receiver.

More on RBDS shows up in Radio World for April 20, 1994. Including a list of curently active FM stations.

Super cheap red and green glasses for 3-D video experiments are offered by Steve Gibson of Deepvision 3-D. Touch switches and driveway sensors are offered by Tapeswitch. A new desktop magazine is Digital Video.

Here are several good servicing resources: Global Micro-Parts Depot has replacement oven parts, both regular and microwave. Appliance Service News describes small appliance and TV repairs in depth. Service News is a trade journal for computer service technicians, and support now in its fourteenth year. The all-ads Computer Hot Line lists sources for printer, hard disk, and monitor parts.

One new monthly pseudoscience publication is Magnets in Your Future. It is intended for motors-and-magnets perpetual motion enthusiasts. The publication is expensive and even more outrageous than most—very strange indeed.

More on book-on-demand publishing appears in my Book-on-demand publishing kit from Synergetics. I also have a brand new catalog with a greatly expanded "insider technical secrets" section. You can write, call, or E-mail me for a free copy.

Most of the items mentioned are found in the Names & Numbers or Dowsing Resources sidebars. Be sure to check here first before calling our no-charge technical helpline. Let's hear from you.          Ω



It's our first experience with interactive TV.

ter than 2:1 (preferably less than 1.5:1), and a monitor capable of receiving channel 3 or channel 4 (VHF). The system is also compatible with European PAL. Standard video levels (1 volt into 75 ohms, negative sync) are supplied by most cameras or other video equipment.

On-board gain controls for video and sound are provided, but external gain controls accessible from a front panel might be desired. Selectable video inputs, audio subcarrier control, frequency switching, and external transmit/receive switching might be required.

● Power Supply—For the transceiver, the DC voltage should be well regulated (1% or better) and be capable of 1.2 amperes or more. For ¾-watt units, any voltage from 8 to 14 volts is acceptable. The higher the voltage, the higher the RF output power. For the 5-watt transceiver and transmitter, higher voltages will be dissipated as heat, so adequate heat sinking must be provided.

Any ripple will show as hum bars in the transmitted video signal. Poor regulation of the power supply can cause video instability, sync clipping, poor low-frequency response, and make it difficult to receive the transmitted video. Do not use a power supply with an output voltage of more than 15 volts because the RF power amplifier will be damaged. Lead-acid or nickel-cadmium rechargeable batteries will permit portable operation.

● Antenna—A good Yagi array, log periodic array, collinear array, or other antenna with 6 to 18 dB or more gain will give far better results than a simple 6-inch whip antenna. (Remember that 5 MHz bandwidth is needed.)

● Monitor—Any black-and-white or color receiver that can tune to channel 3 or channel 4 VHF.

● Camera—Any black-and-white or color camera that provides 1 volt into 75 ohms will be satisfactory. It can be a camcorder, a security camera, or a miniature CCD camera. The miniature CCD cameras consume little power and can operate from 12 volts DC. They are
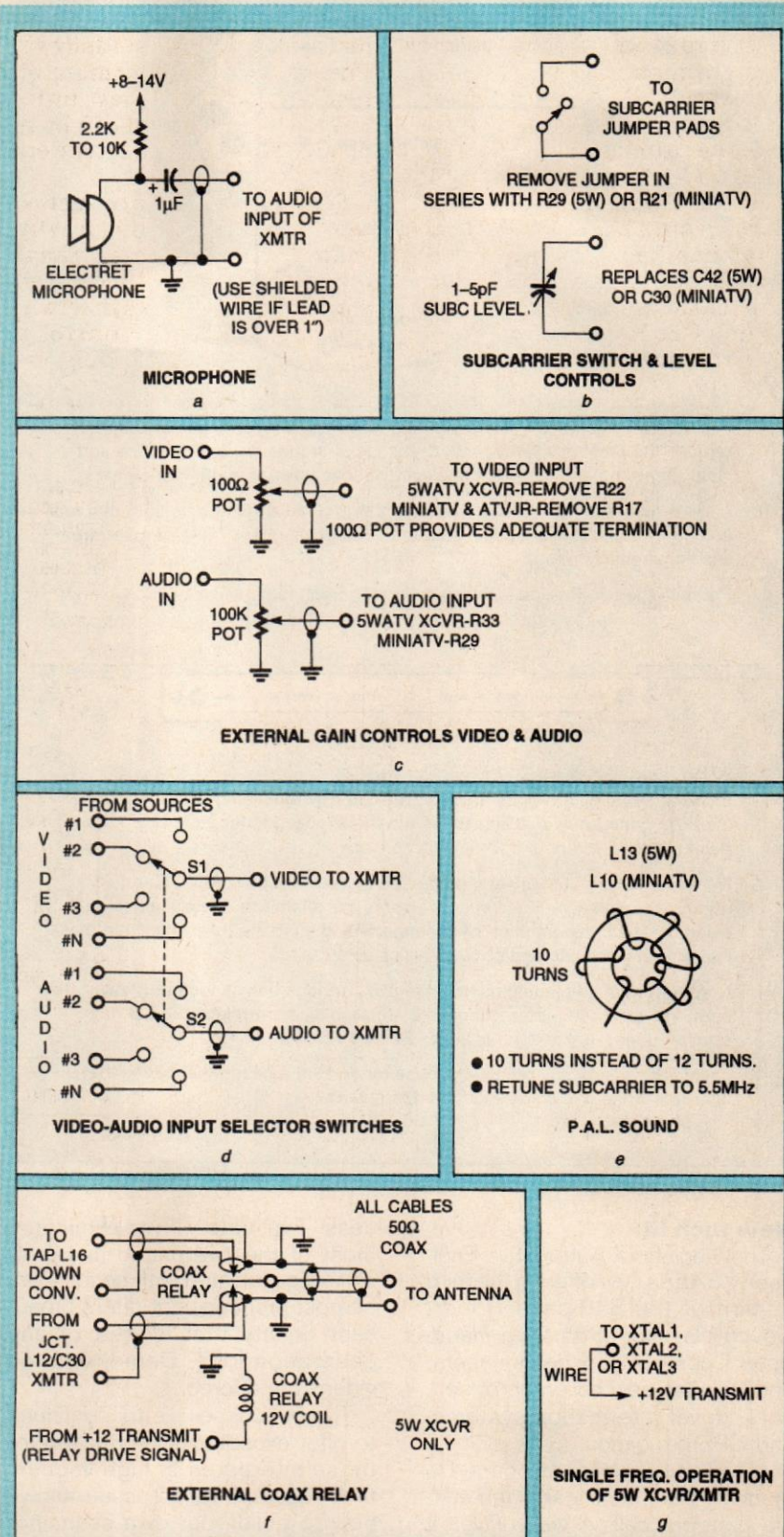


FIG. 14—OPTIONAL ACCESSORIES can be added to the ATV units.