

# Tech Musings

November, 1997

Time saving laser printer testers  
 More on hydrogen developments  
 Inside a submillimeter telescope  
 Radio astronomy resources update  
 Another "homopolar energy" myth

This month, we seem to have a fascinating collection of both pseudoscience and real science topics. Let us start off with the real stuff...

## Radio Astronomy

That world class *Henrich Hertz* SMT submillimeter telescope lies on a small hill in front of my driveway. I recently wrangled a special insider tour. Because it was our monsoon season and between experiments, I even got to get a real close look at what's happening inside the receiver pods. There is some amazing stuff coming down here.

A *radio telescope* is just a big old radio receiver. One that's extremely directional, low in noise, and quite sensitive. They are sometimes used singly. But they might get grouped together into *arrays* using a magic process called *interferometry*.

Some radio telescopes investigate solar and planetary phenomoma in the high frequency range. Others use ordinary microwaves in the 300 MHz to 150 GHz microwave range. 300 Gigahertz has a wavelength of one millimeter. The latest of specialized radio telescopes go well under this one millimeter wavelength, exploring the Terahertz *mystery band* that we looked at back in [HACK84.PDF](#) and [EMERGOP4.PDF](#).

Things get especially challenging in this 100 to 1000 Gigahertz range. First, you must have a quite dry and very high site. Hence the 10,700 foot high hill that blocks my view to the south. Water vapor severely absorbs submillimeter signals. Your receiving dish has to exceptionally conform to its parabolic shape, say a thousandth of an inch or better over thirty five feet. Day in and day out.

You have to work around all the restrictive atmospheric windows that get in your way. And the receiving electronics often has to be chilled to nearly absolute zero. And, oh yeah, nobody yet knows how to construct decent mystery band amplifiers or even power sources. So you are still

stuck with a highly noisy and klutzy electronics technology that today is roughly comparable to microwaves before 1940. Literally a crystal set.

And therein lies a few of the SMT challenges.

If you ever want to make friends with a radio astronomer, offer them stable one Terahertz amplifiers with 20 decibels of gain and an 0.8 decibel noise figure. At \$4.98 per dozen.

Although these new millimeter and submillimeter telescopes can be used for SETI extraterrestrial intelligence searches, most traditional researchers distance themselves from anything related to "E.T. phone home".

Instead, they concern themselves primarily with mapping apparently natural instances of extraterrestrial radio noise sources. One important source for these signals is known as *molecular resonance*.

Two of the most popular are the 21 centimeter hydrogen line at 1420 Megahertz and that 18 centimeter hydroxyl line at 1681 Megahertz. The area between these two makes up a transparent window that's nicknamed the *water hole*.

The presence of energy at or near a molecular resonance usually reveals the presence of that molecule.

Because of a "red shift" *Doppler effect*, modest frequency differences from what is expected can tell you whether an energy source is moving towards you or away from you. Other radio energy sources are associated with pulsars, quasars, black holes and supernovas. They often paint a wildly different picture of the universe than optical telescopes do.

I've summarized some other key molecular resonance frequencies for you in figure one.

## The SMT

This particular SMT handles radio astronomy wavelengths from 0.3 to 2 millimeters. Or frequencies from 150 Ghz to 1000 Ghz. The latter being a full Terahertz. Thus, this scope starts where older millimeter instruments have left off.

The 35 foot dish is in fact accurate to a mil or so. Specifically, their goal was 15 microns of rms error (there's about 18 microns in a thousandth of an inch). Stats are currently under

Deuterium	327.384 MHz	Carbon Monosulphide	48.991 GHz
Hydrogen	1420.406 MHz	Hydrogen Cyanide	88.632 GHz
Hydroxyl	1612.231 MHz	Carbon Monosulphide	97.981 GHz
Hydroxyl	1665.402 MHz	Carbon Monoxide	109.782 GHz
Hydroxyl	1667.359 MHz	Carbon Monoxide	110.201 GHz
Hydroxyl	1720.530 MHz	Carbon Monoxide	115.271 GHz
CH Radical	3263.794 MHz	Formaldehyde	140.840 GHz
CH Radical	3335.481 MHz	Duterated H Cyanide	144.827 GHz
CH Radical	3349.193 MHz	Formaldehyde	140.840 GHz
Formaldehyde	4829.660 MHz	Carbon Monosulphide	146.969 GHz
Water Vapor	22.235 GHz	Formaldehyde	150.498 GHz
Ammonia	23.694 GHz	Carbon Monoxide	219.560 GHz
Ammonia	23.723 GHz	Carbon Monoxide	220.399 GHz
Ammonia	23.870 GHz	Carbon Monoxide	230.538 GHz
Excited Hydrogen	36.466 GHz	Methanol	258.507 GHz
Silicon Monoxide	42.821 GHz	Hydrogen Cyanide	265.886 GHz
Silicon Monoxide	43.122 GHz	Carbonyl Sulphide	461.907 GHz

Fig. 1 – SOME MOLECULAR RESONANCE FREQUENCIES of interest to centimeter, millimeter, and submillimeter radio astronomers.

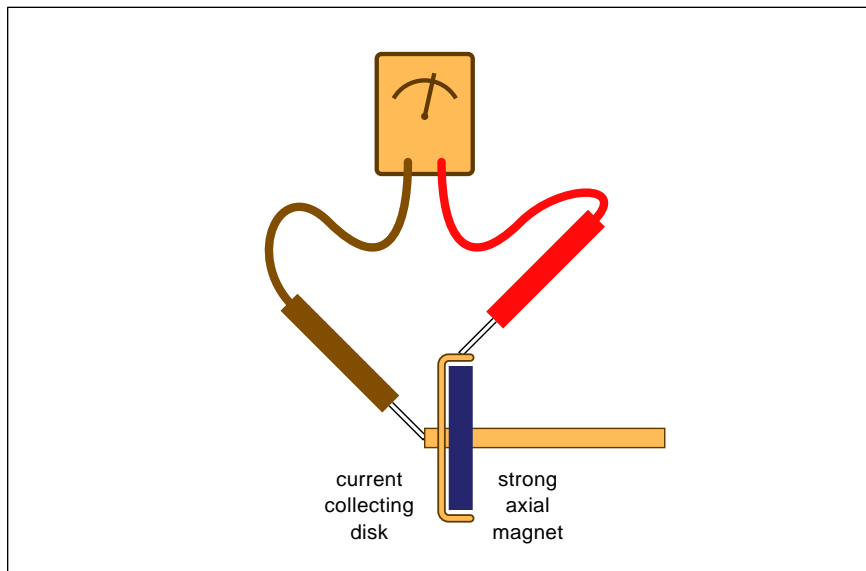


Fig. 2 – "FREE ENERGY" ENTHUSIASTS claim to see a homopolar voltage with zero relative motion between a spinning magnet and collecting disk. Sure enough, you can easily convince yourself you are measuring some disk voltage or current. If you are careless enough about your bad labwork.

twenty microns or so and improving. At present, this is the finest SMT dish anywhere in the world.

This dish is set up as an AZ-EL mount, an abbreviation for *azimuth and elevation*. Most of the azimuth part is handled by *rotating the entire building!* Special "windup" cables and flexible pipes let their building

spin 270 degrees in either direction. At a 60 degrees per minute clip, even. Elevation is handled by tilting the dish over an -2 to 91 degree range.

There is a secondary *Cassegranian* reflector way out in front near the parabolic dish focus. Reached by a scary circus tightrope platform. The secondary in turn will reflect their

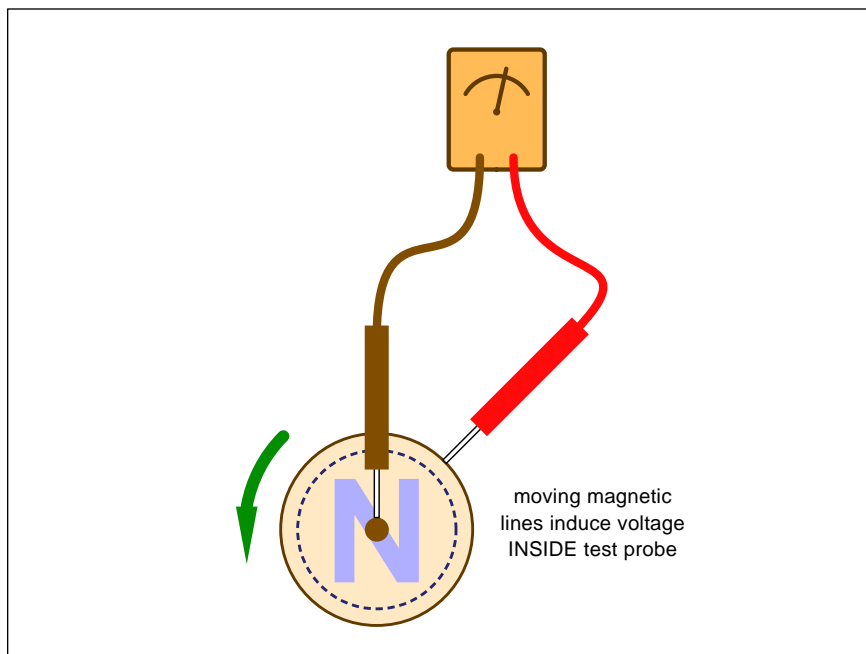


Fig. 3 – BUT AN END VIEW clearly shows what is really happening: The voltage or current you see is generated INSIDE of your test lead by plain old induction. Your test leads form a one turn stator winding loop!

received beam on down through the middle of their dish. At that point, a flippable mirror then deflects their beam out a chosen end of the *middle* of the elevation axle.

The beam then goes to one of two *receiver pod* rooms. The neat thing about this setup is that the intended receivers can be bolted down onto fixed optical benches in more or less ordinary rooms. With use of beam splitters, up to six experiments (three on each side) might get conducted nearly at once.

The secondary reflector also gets used for minor tracking (ever try to smoothly move a building by a few microns at a time?). The secondary is also used to purposely switch on and off axis, modulating your beam for better detectability. This is an update of the ancient astronomical "blink comparator" technique. Their typical chopping frequencies are 10 Hertz or 25 Hertz, depending on need.

I'm also told you can hang a dipole on the secondary to make a dandy two meter ham receiver. Their 200 mile line-of-site visibility does not hurt DX all that much, either.

Back in the receiver rooms, two different technologies can be used at one of the six selectable focal points. Several frequencies can be monitored at once. A *bolometer* is a broadband heat detector. It can determine the overall energy being received.

The other option can be a tunable superhetrodyne receiver. Their *Gunn* diode oscillator and multiplier chain generates a frequency near that of the intended reception frequency.

This *local oscillator* frequency is beamed together with the received signals through a window onto a supercooled SIS tunnel junction diode. The two beams interact with the diode's nonlinearity, producing sum and difference signals. The new difference signal gets routed to a microwave intermediate frequency amplifier chain.

From there, the received signal is further downconverted, is amplified, filtered, and then gets digitally signal processed. The usual output is in the form of an intensity map.

Often in pretty false colors.

Ah yes, the cooling. Much of the universe lies at a "night sky" temp of 4.5 degrees Kelvin. Four degrees

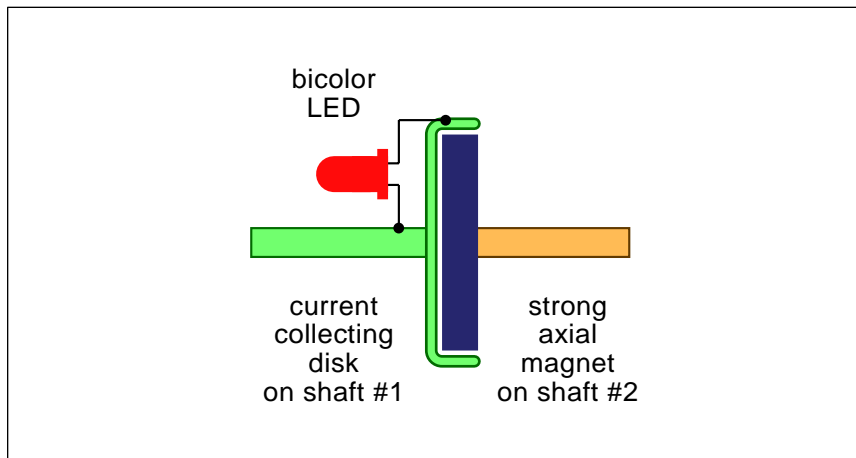


Fig. 4 – A "STATORLESS" TEST SETUP to quest for mythical homopolar currents. I would expect the LED to light to one color given enough positive relative rotation, and light to the other color on enough negative relative rotation. Brightness should be INDEPENDENT of absolute magnet speed.

above absolute zero. Ideally, your detector should be substantially *less* than this value. Critical portions of the receiver electronics are placed in special *Dewars*. These are related to plain old thermos bottles, but might be the size of a commercial soft drink supply cannister.

Liquid nitrogen is first used as an intermediate cooler. It turns out that ordinary liquid helium-4 boils at 4.22 degrees Kelvin. But there is a magic and stupendously expensive helium-3 isotope which boils at a significantly lower temperature. By evaporatively diffusing helium-3 into helium-4, a special cryogenic refrigeration device offers cooling to *within a fraction of a degree of absolute zero*.

Since there is only one naturally occurring helium atom out of 10,000 that is this magic helium-3, special and elaborate recycling compressors recover and reuse this elixir.

The SMT's website is located at [maisel.as.arizona.edu:8080](mailto:maisel.as.arizona.edu:8080). Bunches more info here. Seasonal Saturday tours are available through the folks at *Discovery Park*. All day tour costs are around \$30. More details on tours and their amateur astronomy club at [www.discoverypark.com](http://www.discoverypark.com)

### Some Resources

A superb collection of state of the art submillimeter receiver papers is available for your free downloading at [cfarx1.harvard.edu.ix\\_lab/papers](http://cfarx1.harvard.edu.ix_lab/papers) For lots more, just search the web under "submillimeter".

I have gathered a few additional radio telescope names and numbers for you as this month's resource sidebar. One good starting point is the [NRAO at info.aoc.nrao.edu](http://info.aoc.nrao.edu)

That VLA outside of Magdalena, New Mexico is certainly worth your visit. Little known near here is the secret *Langmuir* thunderstorm lab on the next mountain over; even lesser known is that summer visitors are welcome to this remote site.

There's also a *Society of Amateur Radio Astronomers*. An individual by the name of Jeffrey Lightman now publishes *Amateur Radio Astronomy: Systems, Procedures and Products*. It is sold through his *Radio Astronomy Supplies*. Cost is \$40. He also carries the Robert Sickels *Radio Astronomy Handbook* at the same price. Plus lots of other books, videos, hardware, and software. A 1420 Megahertz receiver sells for \$1420.

One good journal I've found on submillimeter receiver technology is the *International Journal of Infrared and Millimeter Waves*. And the *IEEE Transactions on Microwave Theory and Techniques* is also useful.

Many hundreds of radio astronomy books are stocked by Amazon Books at [www.amazon.com](http://www.amazon.com) One pricey title is *Instrumentation and Techniques for Radio Astronomy* from the folks at the *IEEE Press*.

As to amateur astronomy resources in general, I have just posted a hot linked download as [RESBN67.PDF](#) on my <http://www.tinaja.com>

### The Enigma of The Faraday Disk

There is a cute variation on the homopolar generators we looked at last month. This one is newly kicking around the web. Some pseudoscience enthusiasts may show you a "simple experiment" which "proves" you get homopolar energy when there is *zero* relative motion between the moving magnet and its collecting disk.

Naturally, I believe this claim lies somewhere between "a useful adjunct for porcine whole body cleanliness" and total hogwash.

Figure two shows the scheme. A strong axially polarized disk magnet is placed on a shaft next to a fixed collecting disk or cup. Spin these both with an electric drill, and sure enough, you could easily convince yourself you are measuring voltage and current from shaft to the edge of the disk. With zero relative motion between the two.

Too bad it ain't so.

Take a close look at the bottom inch of your shaft *test probe* in figure three. You have got moving magnetic flux lines cutting a conductor. Ergo, classic physics tells us you'll get an induced voltage. The voltage you see is generated *inside* of your test probe, *not* across the collecting disk!

To prove this yourself, just move your probes around. In particular, I'd certainly expect your polarity would *reverse* if you put the probe on the *other* side of the magnet.

One more time: The voltage gets induced *inside* of your test probe! Yes, across a one inch straight wire of negligible resistance. You have a one turn stator coil formed by your test probes and leads.

The voltages and currents claimed suggest hundreds of microwatts of power. The usual measurement error "fumes" you'll probably find in most any lab. I'd expect a modern magnet at high speeds to produce watts to tens of watts in a real generator. I'd also be wary of measurements that are *one-millionth* of the field energy present in the nearby electric drill.

It seems that Faraday himself also felt he observed a homopolar output with a zero relative motion between rotating collector and magnets.

Was Faraday right? In which case

SOME RADIO ASTRONOMY RESOURCES

**Caltech Submm Obsty**

111 Nowelo St  
Hilo HI 96720  
(808) 935-1909

**Discovery Park**

1651 32nd St  
Safford AZ 85546  
(520) 428-6260

**Harvard Submm Array**

60 Garden St  
Cambridge MA 02138  
(617) 495-7489

**Hat Creek Observatory**

42231 Bidwell Road  
Hat Creek CA 96040  
(916) 335-2364

**IEEE Press**

445 Hoes Ln  
Piscataway NJ 08855  
(908) 981-0060

**IEEE Trans Microwaves**

445 Hoes Ln  
Piscataway NJ 08855  
(908) 981-0060

**Int JI Infrared & mm Waves**

233 Spring St  
New York NY 10013  
(212) 620-8000

**Jet Propulsion Laboratory**

NASA  
Pasadena CA 91109  
(818) 354-5011

**NRAO Observatory**

PO Box 2  
Greenbank WV 24944  
(304) 456-2011

**Radio Astronomy Supplies**

190 Jade Cove Drive  
Roswell GA 30075  
(770) 992-4959

**Radio Sky Publishing**

PO Box 3552  
Louisville KY 40201  
www.win.net/~radiosky

**SETI Institute**

2035 Landings Dr  
Mountain View CA 94043  
(415) 961-6633

**SETIQuest**

174 Concord St  
Peterborough NH 03458  
(603) 924-9631

**SMT Telescope**

University of Arizona  
Tucson AZ 85721  
(520) 621-5290

**Soc Amateur Radio Astron**

247 N Linden St  
Massapequa NY 11758  
(516) 798-8459

**VLA Astronomy Site**

PO Box "O"  
Socorro NM 87801  
(505) 772-4011

nobody's bothered to commercially develop an obviously powerful new generator in the last 162 years? Or was Faraday wrong? Making a subtle but simple lab error in which all of the observed voltages were generated inside of his test leads?

I feel the elegantly simple test of figure four can easily sort this out. The trick is to eliminate any "stator" on your machine and *get rid of all measurement wires*. Instead, you'll *immediately* convert your generated electricity to light.

Do this by soldering a two-color LED between the center and the edge of your collecting disk. Then arrange for the disk and your magnet to be *separately* rotatable.

Here's what I'd expect to happen: Keep the magnet stationary and then rotate the disk fast enough to light the LED to normal brightness. Now, start spinning the magnet in the same direction as the collecting disk.

As the magnet speed increases, I'd expect your LED to *dim*. When the magnet speed is zero relative to the collecting disk, I'd certainly expect zero light output. And as the magnet speeds up I'd expect brighter light of the opposite color.

Results should depend *only* on the *relative* speeds between your disk and the magnet. And *not* upon the *absolute* speed of the magnet.

If I am wrong on the results of this simple experiment, I will be most happy to publicly apologize. But then again, you won't be worrying about

this, because your picture will be on the cover of *Science* magazine.

Many thanks go to Bill Beatty of [www.eskimo.com/~billb](http://www.eskimo.com/~billb) for all his "look at the stator" comments on this. Visit his great web site that covers both real science and pseudoscience in depth. Details on the experiment itself can be found lurking around [www.keelynet.com](http://www.keelynet.com).

And much more on pseudoscience is at [www.tinaja.com/pseudo01.html](http://www.tinaja.com/pseudo01.html)

**A Clarification or Two**

Uh, whoops. The energy density figures in my recent hydrogen story were high by 1000. Hydrogen has an energy density of around 38,000 *watt* hours per liter or 38 *kilowatt* hours per liter. All these values have been corrected in [MUSE115.PDF](#).

Sorry about that.

One individual was critical of my failing to include *Brown's Gas* in my recent hydrogen story. *Brown's Gas* is a stoichiometric mix of two parts of

hydrogen to one part of oxygen. It sees some limited commercial use in specialized welding torches.

But unquestioning Brown's Gas enthusiasts make outrageous claims, such as overunity energy production, radioactive waste neutralization, and even negative pressure generation.

All without credible and verifiable proof to any acceptable standards. At least none that I've seen.

I strongly feel that Brown's Gas clearly passes my subjective "looks like a duck - quacks like a duck - is gonna lay some eggs" pseudoscience test. If for no other reasons, because of the outlandish claims and nature of the totally clue-challenged denizens it attracts to the web.

Pseudoscience is a field I closely monitor. Because it includes such mesmerizingly awful fiction.

Stuff that is not even wrong.

If I ever do discover any credible evidence to the contrary, I'll be most happy to research Brown's Gas in more depth and thoroughly report it. I do not expect this to happen until after the Ayatolla's bar mitzvah.

More on [tinaja.com/pseudo01.html](http://tinaja.com/pseudo01.html)

**New Tech Lit**

There's a whole flock of new and free CD ROM data disks this month: From *Texas Instruments*, the *Logic Selection Guide and Data Book*. Or from *Hitachi*, their *H8/300 Series Embedded Microprocessors*. From *Sharp*, a *Flash Memory Data Book*. And from *Ricoh*, full details on *CD*

**NEED HELP?**

Phone or write all your US Tech Musings questions to:

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Synergetics  
Box 809-EN  
Thatcher, AZ, 85552  
(520) 428-4073

US email: [don@tinaja.com](mailto:don@tinaja.com)  
Web page: [www.tinaja.com](http://www.tinaja.com)

## NAMES AND NUMBERS

**Alsa Softouch**

2640 E 37th St  
Vernon CA 90058  
(213) 581-5200

**Applied Microwave & Wireless**

2245 Dillard St  
Tucker GA 30084  
(770) 908-2320

**Hitachi**

2000 Sierra Point Pkwy  
Brisbane CA 94005  
(415) 589-8300

**Home Power**

PO Box 520  
Ashland OR 97520  
(916) 475-3179

**Innovation**

2011 N Shoreline 21L-415  
Mountain View CA 94043  
(415) 933-6502

**KeelyNet BBS**

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

**Langmuir Laboratory**

NM Inst of Min & Tech  
Socorro NM 87801  
(505) 835-5423

**Laser Wizard**

705 G Washington Ave  
Norrilstown PA 19403  
(610) 539-4708

**Lindsay Publications**

PO Box 538  
Bradley IL 60915  
(815) 935-5353

**Newnes**

313 Washington Street  
Newton MA 02158  
(617) 928-2500

**Recharger**

4218 W Charleston Blvd  
Las Vegas NV 89102  
(702) 438-5557

**Ricoh**

3001 Orchard Parkway  
San Jose CA 95134  
(800) 957-3436

**Science/AAAS**

1333 H St NW  
Washington DC 20005  
(202) 326-6400

**Sharp**

Sharp Plaza  
Mahwah NJ 07430  
(201) 529-8757

**Synergetics**

Box 809  
Thatcher AZ 85552  
(520) 428-4073

**Texas Instruments**

PO Box 809066  
Dallas TX 75380  
(800) 336-5236

**Don Thompson**

6 Morgan #112  
Irvine CA 92718  
(714) 855-3838

**Wireless Design & Dev**

301 Gibraltar Dr  
Morris Plains NJ 07950  
(201) 292-5100

**Recording Media**

*Home Power* magazine has newly come up with their greatly improved *Solar 2* CD ROM. This one uses the latest version of *Acrobat* for totally searchable and full color images of 3900 pages of *Home Power*. From Issue #1 through #42. Topics include everything from photovoltaic cells on up through electric vehicles to solar cooking to water pumping and more. \$29 including US shipping.

Several exciting new laser printer repair instruments are newly offered from *Laser Wizard*. These calculator size units plug into popular *Canon* engines and give you all sorts of new found diagnostic and control powers. Their PIC-based \$295 SX30 is the basic unit for SX engines. Add-on

\$99 adaptors are available for the NX and BX engines. These can let you manually control the printer at the engine level while overriding cover switches and reading error messages.

Laser printer training and repair parts still remain available from *Don Thompson*, while cartridge refilling opportunities abound in *Recharger* magazine ads and stories.

More on the neat things you can do with toner in [RESBN68.PDF](#).

Free samples of a new ultra-tough *Softouch* leather-like coating from *Alsa*. Freebie electrochemical milling samples from *Fotofabrication*.

New books from *Newnes* include an *Inside PC Card Design* by Faisal Haque and *Cellular Telephones and Pagers Overview* by Steve Gibson.

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Hardware Hacker II, III or IV	\$24.50
Micro Cookbook I	\$19.50
PostScript Beginner Stuff	\$29.50
PostScript Show and Tell	\$29.50
Intro to PostScript Video	\$29.50
PostScript Reference II	\$34.50
PostScript Tutorial/Cookbook	\$22.50
PostScript by Example	\$32.50
Understanding PS Programming	\$29.50
PostScript: A Visual Approach	\$22.50
PostScript Program Design	\$24.50
Thinking in PostScript	\$22.50
LaserWriter Reference	\$19.50
Type 1 Font Format	\$16.50
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Whole works (all PostScript)	\$380.00
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## Tech Musings

The latest of "new" old titles from *Lindsay Publications* do include *I.C. Engines Volume I*, his collection of patents on early internal combustion engines. And new books on lathes, saw blade, and milling machines.

Url is [keynet.net/~lindsay](http://keynet.net/~lindsay).

There is a brand new *Innovation* publication for you users of high end graphics computers. It is apparently a continuation of an older *IRIS Universe*

magazine. Free subs to those with a genuine interest.

Two useful wireless trade journals are *Applied Microwaves & Wireless* and *Wireless Design & Deveopment*.

For the insider secrets of starting up your own technical venture, see my *Incredible Secret Money Machine II*. From my nearby *Synergetics* ad. You can also preview the intro at my [www.tinaja.com/ismm01.html](http://www.tinaja.com/ismm01.html) Also

check my new *Infopack* service that quickly gives you custom and cost effective research solutions.

As usual, most of the mentioned items should appear in the *Names & Numbers* or in the *Radio Astronomy Resources* sidebars. Always do check here before you call our US technical helpline shown in the *Need Help?* box you'll find nearby.

Let's hear from you. ♦