speleonics 13 OCT. 1989

"BETTER CAVING THROUGH ELECTRICAL STUFF" volume IV number 1

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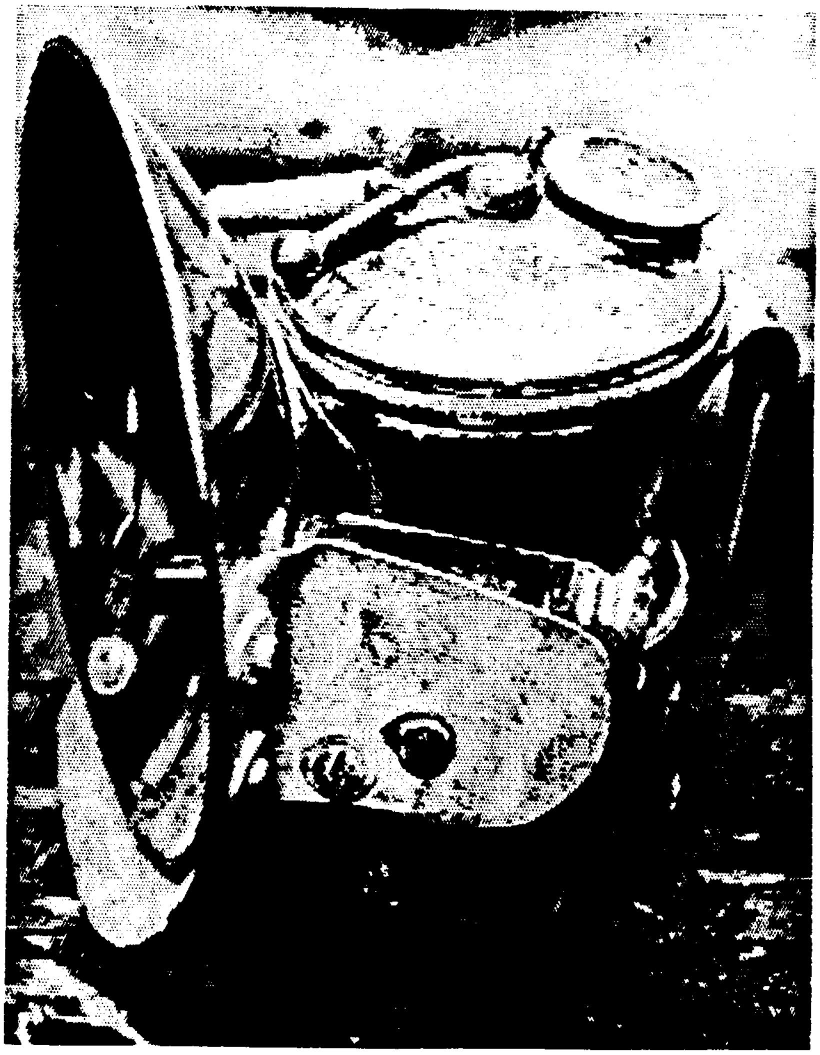

VINTAGE CARBIDE LAMP WITH PIEZOELECTRIC IGNITION

Piezoelectric spark-generators work even when wet, an advantage over conventional flintwheels. See **John Ganter's** article on page 3.

SPELEONICS 13

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SPELEONICS is published approximately four times per year by the Communication and Electronics Section of the National Speleological Society (NSS). Primary interests include cave radio, underground communication and instrumentation, cave-rescue communications, cave lighting, and cave-related applications of amateur radio. NSS membership is encouraged but not required.

Section membership, which includes four issues of SPELEONICS, is $4.00 in USA/Canada/Mexico, $6 overseas. Send subscriptions to section treasurer Joe Giddens at the address below (make checks payable to SPELEONICS.) If you have a ham-radio callsign or NSS membership number, please include them when subscribing.

Foreign subscriptions can be paid in U.S. "paper" dollars in the mail; an international money-order may cost as much as the subscription itself. Many members have sent cash without problems. (No foreign currency, please.)

Editorship rotates among the officers. Volunteers are encouraged to guest-edit or produce an issue. A technical session, followed by election of officers, is an annual event held during the NSS Convention.

Complimentary copies of SPELEONICS go to NSS offices and sections, the U.S. Bureau of Mines, U.S. Geological Survey, and the Longwave Club of America.

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LETTERS

Dear Frank,

A friend of mine is a police officer. A police-equipment company sent him a crate of catalogs, including one from a company that I thought you might be interested in knowing about.

ALEXANDER BATTERIES of Mason City, Iowa specializes in rechargeable batteries, mainly NiCad types. The catalog also shows quite a selection of sealed lead-acid batteries that look like gel-cells. They have sales reps all over the U.S. and Canada, and in Europe. It might be worth contacting them for catalogs and price lists to see if they are a good source of gel-cells and NiCads. Phone numbers of some of their reps:

Southern USA:
Alexander Battery Co.
Arlington, TX
1-800-323-3813
1-817-467-5434
Jim Lewis

Central USA:
Alexander Battery Co.
McHenry, IL
1-800-323-3813
1-815-344-0666
Sue Grandt

Eastern Canada:
Kilpatrick Communications & Controls
Weston, Ontario, Canada
1-800-387-5865
Bob Kilpatrick

The people who sent the catalogs to my buddy are:

Police Safety League, Inc.
300 S. 3rd St.
Lemoyne, PA 17043
1-800-338-3610
1-717-761-6376

James Savage
P.O. Box 748
Hurst, Texas 76053

Maverick Grotto
DFW Grotto
Texas Speleo. Assoc.

Ed note: Alexander Batteries had a booth at the Dayton Hamvention.

--

May 16 1989

Dear Frank,

...I wonder if John Halleck has thought of using the HP super LED in a communications mode. I have been experimenting with IR units in a synchronous detection mode and observing very large range. It would seem that a multi-bounce mode inside a cave is a possibility... Pulsed LEDs are capable of even higher outputs.

Dave Ursin (page 3) wants PC boards for the "Organ Cave Radio." If a PC layout exists, see <u>QST</u> April 89 p.168-- FAR Circuits. He will make any circuit very inexpensively. I think there are enough members around to where he will take the project.

Lastly, regarding batteries, the lithium cell can not be ignored!

9V transistor battery	1.2 AH
6V cell, 1/2" diameter, 1" long	160 mAH
6V pack 1.7 x 1.4 x .67"	1.3 AH

Shelf life is very long. All marketed by Kodak but others must be about to join in.

73,

Cliff Buttshcardt W6HDO
950 Pacific St.
Morro Bay, California 93442

--

Dear Joe:

In Speleonics 12, Ron Johnson wrote a letter regarding a "standard" two-pin connector for radios and other equipment. He says, "Basically, y'all picked the wrong kind of connector!"

The original "Communications Standard #1.0" [published in Speleonics 2] was devised, I believe, by Gene Harrison in 1984 to serve as a standard for the Appalachian Search and Rescue Conference members. At that time, the Eastern Region NCRC was affiliated with the ASARC, at least in a loose manner. I am unsure whether a formal agreement was in effect at that time. I assume others were involved in the choice of the two-pin Jones plug, but I don't know their names to give credit.

The purpose was to provide a standardized, simple plug which could be used to connect two-way radios and other devices to a 12 volt DC source. One of the main considerations was that the plug be easy to obtain. The Jones plug was, at the time, available in every Radio Shack store in the United States and Canada. It was, therefore, a suitable choice at that time. Of course, it did have the shortcoming of being too easy to disconnect; however, there were locking versions availables for those who wanted to use them, or it could be secured with a strip of tape.

Even in those early days, many of us, especially those living in large cities with a wider range of retail outlets, would have chosen a more robust, locking connector. But we supported the choice of the Jones plug, since it was available almost anywhere, and easy to use. Mr. Harrison should be commended for his efforts in standardizing the connector. His choice was valid for the time, and he certainly did not choose "the wrong kind of connector."

But times change, and now Radio Shack has discontinued the connector. We need to select a new device, or obtain a supply from other sources; the Jones plug is fairly common still.

I am concerned that the connector proposed by Mr. Johnson may not be suitable. Is this connector made only with pin diameter, length and spacing as standardized to one set of dimensions, or is it, as I suspect, made by a number of manufacturers in slightly different dimensions? We would be in an awful mess if that were the case.

The 1989 Canadian Radio Shack catalog shows two possibly suitable connecot choices: one is described as #270-025, a four-foot polarized fused DC power cable, and the other as #270-026, a quick-disconnecto 2-conductor 12" cable.

If we are going to select a new connector, let's be very cartain that our choice is wise. We need a connector that is readily available, rugged, capable of carrying sufficient current, resistant to corrosion, and not prone to disconnecting itslef on every pothole in the road. I am sure other readers can add to the criteria. Let's make our newsletter serve us by calling for all readers to send in theri list of recommended criteria; the editor can compile a list of desired characteristics, and publish same, and then we can look at which connectors are available to meet the need. This may seem like an involved process, but it will be worth the work if we can arrive at a choice which will serve us well for the next ten years or so.

Another important consideration is whether we should now start to identify 12-volt versus 13.8-volt sources: this can be very important in some of the newer VHF radios. Let's kick this around a bit.

Finally, let me say that I believe standardization of equipment, where possible, to be a very important goal. Two years ago, on the catwalk at Bridge Day, I came upon a walkie-talkie which was made up of an antenna with Gene Harrison's color code, a body belonging to Bruce Bannerman, and a battery pack with my own color code. Had it not been for standardization, whoever assembled a working radio from the parts of three which were not working could not have done so, and we sould have had one less to work with. Standardization can pay off... it is well worht the effort.

Best Wishes,

Bernie Roche
Eastern Canada Region Co-ordinator,
National Cave Rescue Commission,
Suite 802,
8 Godstone Road,
Willowdale, Ontario, Canada M2J 3C4

News and announcements

1989 NSS CONVENTION REPORT

In our fifth annual NSS Convention Electronic Session, **Ray Cole** discussed battery chargers, including his experiments with a commercial microprocessor-controlled battery test unit.

Frank Reid demonstrated the Casio altimeter wristwatch (see New Products colum in this issue). Frank also demonstrated an experimental circular-polarized VHF antenna for radio communication in pits. The antenna should help eliminate signal cancellations (dead spots), and should work in passive or active repeater systems.

Roger Bartholomew announced at the convention photography session that the last major manufacturer of flashbulbs will discontinue production, causing hardship for cave photographers. **Bill Storage** is coordinating design of a high-power electronic flash optimized for caving.

John Halleck demonstrated a sample of Hewlett-Packard's 20000 millicandela LED (very impressive!). He had hoped to have a supply of them at the convention (as announced in SPELEONICS 12), but reports that HP has encountered production problems. John also demonstrated a long-duration emergency cave light made from an array of nine high-intensity (2000 mcd) LEDs from Radio Shack.

Bob Buecher described and showed slides of the meteorological instrumentation project in Kartchner Caverns, Arizona. A computer-controlled data gathering system monitored temperature, humidity and other factors at multiple locations. A similar project headed by **Warren Lewis** will soon investigate wind and other phenomena at Lechuguilla Cave.

Castleguard 1988: A Cave Radio at Castleguard Cave was shown. See details elswhere in this issue.

Once again, incumbent section officers were re-elected

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COMPLEX COMMUNICATIONS SCENARIO AT NCRC MOCK-RESCUE

A day-long mock rescue at **Russell Cave National Monument**, Alabama climaxed the 1989 1-week National Cave Rescue Commission (NCRC) training seminar at Monteagle, Tennessee. The scenario involved about 100 people and three caves. Some of the five entrances used were separated by more than one mile, demonstrating the value of proper antenna orientation with handheld radios. Communications systems were the most complex yet seen at an NCRC seminar. Students supplied adequate numbers of compatible VHF radios, and the usual initial procedural problems were quickly solved. Participants praised the ability to directly link underground telephones with surface radios, as provided by **Danny Britton**'s experimental VOX-operated phone patch, which was tested under realistic conditions. It can simultaneously link radios, field phones and commercial phones, and contains AGC amplifiers, loudspeaker, tape recorder and integral telephone. We hope to publish the plans in SPELEONICS.

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Members and friends attending cavers' meeting at the 1989 Dayton Hamvention:

Mary Allsopp	**Bob Horvitz**
Bill Allsopp W5TJI	**Lance Lide**
Don Conover	**Frank Reid**
Dean Harris KK4EB	**Gary Taylor**

Again, some people were unable to find the meeting. We will try an outdoor location next year, weather permitting.

PIEZOELECTRIC IGNITION FOR CARBIDE LAMPS

by John Ganter *

Today there are many high-tech ways to make light, but the open yellow flames of carbide lamps remain in caving. Like the flashbulb, the carbide lamp resists obsolescence because of the special demands of caves and caving. The only weakness is the ignition system, typically a flint and steel striker which fare poorly when hostile conditions like water, spray and mud are encountered.

The obvious solution is to borrow recent technology in the form of piezoelectric crystals. These substances produce a high-voltage (15,000 volts plus) discharge when struck sharply. Since no power supply or storage is required, they are common in gas ranges, etc.

Petzl of France uses piezoelectric ignitors to light their carbide lamp fixtures, which are supplied with gas though a tube from a remote-generator hanging at waist or shoulder. The ignitor design is Ferdinand Petzl at his best (Figure 1). The caver turns a knob and a number of things happen in rapid sequence: (1) the assembly pivots and cups gas above the burner tip; (2) meanwhile a small hammer is being cocked; (3) the hammer releases and fires the ignitor; (4) the assembly retracts quickly from the flame. This overall lighting system works pretty well in walking-size caves where the dangliness is not a problem, but US cavers have tended to stick with their caplamps.

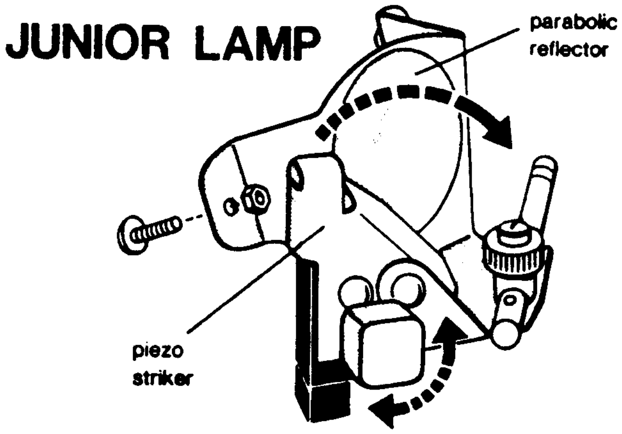

Fig. 1. The Petzl Piezo Striker, on the "Junior" lamp (Bob & Bob catalog).

Bill Mixon (1981; 1982) and **Mark Minton** (1982) have adapted a "generic" piezo unit (available through Speleoshoppe for about $10) for use with caplamps. This cylindrical unit is activated by a pushbutton, and sends the discharge through two wires to electrodes arranged across the burner tip (Figure 2). **Donald G. Davis** (1986) has experimented further with the very small, very cheap piezo units in a variety of butane lighters, but found they did not hold up well under cave conditions (1987). The Mixon-type system is not hard to build, but I set out to design one that would be even easier. I did not succeed, but the results may be of interest anyway.

My idea was to use the Petzl unit, since they are widely available (about $15 from Bob & Bob) and I had one handy. I wanted to be able to transfer the unit and reflector between various caplamps, and also to put it on the Premier "Peak" fixture. This is the only remote-generator fixture available with a horizontal flame; it comes with a flint striker. I like it because the vertical flames of the Petzl fixtures are wasteful and coat the reflectors with soot. Since the Peak will often produce a 6-inch flame, I have installed an aluminum "visor" (visible in Fig. 7) to keep the glare out of my eyes.

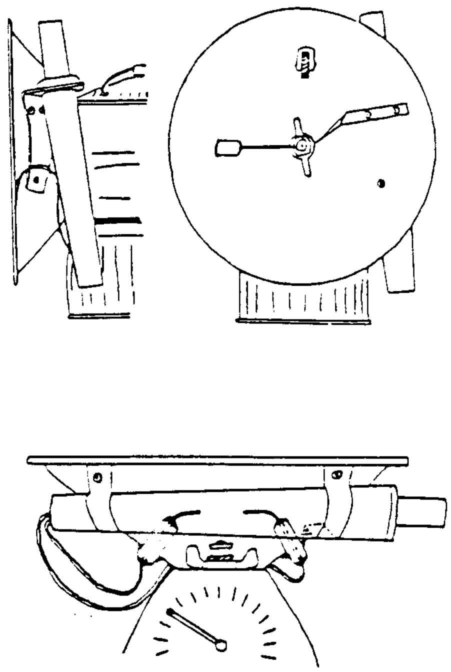

Fig. 2. The Mixon-Minton Piezoelectric Ignitor. Drawn by Bill Mixon, in Minton (1982).

My first thought was to simply emulate the swing-and-fire approach used in the Petzl fixture, but this stuck out to front and side on a caplamp, and required a segment to be cut out of the reflector. Extending the Mixon-Minton approach was somewhat challenging. A high voltage had to be carried through a wet environment. The piezo unit had to be kept away from the flame. The reflector was a heat shield but also a voltage leak. The electrodes had to be rugged since they would not swing out of the way as on the Petzl fixture.

THE PLITER-87. The design I came up with in 1987 is based on a stock ignitor (Figure 3) that has part of the aluminum cowling cut away. The existing barb electrode (Figure 4) is replaced with a spring electrode (Figure 5). The only way that this can be held in the plastic case of the Petzl unit is by friction. I wrapped the spring wire around a needle file until it was a tight coil, and forced it in snugly.

---

* RD 6 Box 338
Bedford, Pennsylvania 15522 USA

I secured the whole unit to a bracket made from aluminum, then inserted it through the reflector. (For longest life, the reflector should be a stainless steel model, available from Bob & Bob) The final step was covering the end with a permanent cap. I formed this by filling an electrical wire nut (a Buchanan 2007 Splice Cap Insulator) with PC-7 epoxy and slipping it over the electrode (Figure 6). The second electrode is a piece of heavy paper-clip wrapped around under the wingnut which holds the reflector on.

Since the knob stuck out, I sawed it off, filed some grooves into the hammer, and fired the unit by pulling this back with my thumb (Figure 7). This model has worked well for a couple of hundred hours of nasty caving. When lying on my side in crawlways, the flame will often burn the cap and epoxy and produce fumes. Still the electrodes have held up, requiring only an occasional alignment. The piezo unit is ferrous, so it must be kept away from compasses.

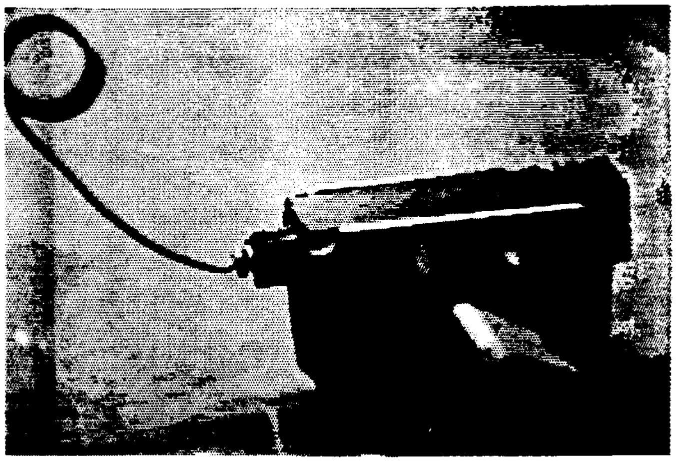

Fig. 5. The spring electrode in place.

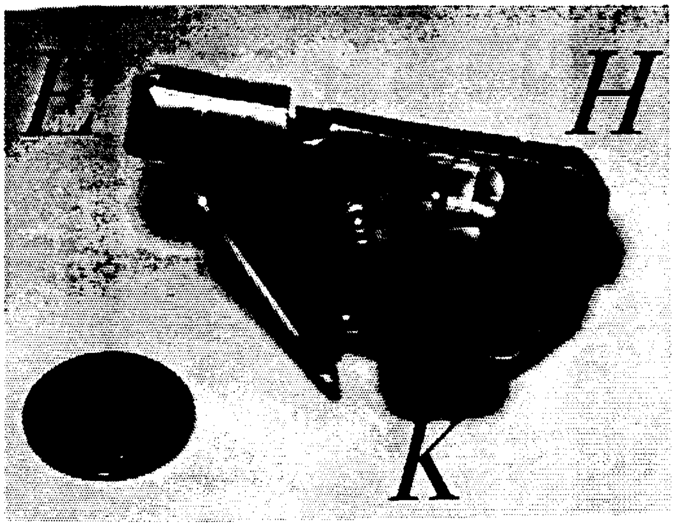

Fig. 3. The Petzl piezo unit. E: electrode end, covered by aluminum cowling. K: firing knob. H: firing hammer.

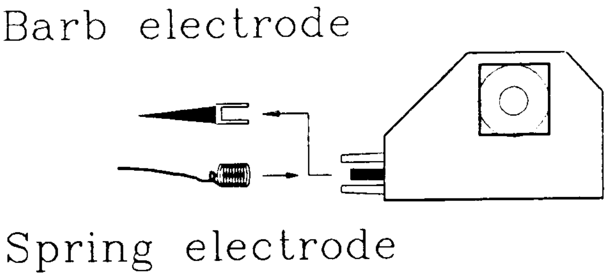

Fig. 4. Removing the barb electrode, and replacing it with a hand-wound spring electrode. Each is held in the plastic housing by friction.

THE PLITER-88. The next year I wanted to make more of these ignitors, since I was getting tired of returning through low airspace and other fun in order to re-light companion's lamps. It seemed that there might be a way to retain the small profile of the PLITER-87, while making the electrode easier to fabricate. So I decided to try and build a completely waterproof insulated joint between the Petzl unit and a piece of wire which would carry the discharge.

Instead of the spring electrode, I discovered that a solderless ring terminal (AWG 16-14, for #8 or #10 stud) fit snugly in the Petzl unit. I soldered a piece of 14 gauge solid copper wire to this to form a sturdy conductor and electrode. Then I fixed the whole assembly in a vise, sealed the openings in the cowling with tape, and potted it with resin of the type used for auto and boat repairs (Figure 8). Final insulating touches were put on with GOOP adhesive sealant.

I mounted the unit with pop-rivets, and used the flint-striker hole to feed the wire through (Figure 9). The completed PLITER-88 has done well so far. It is compact, fits well on a helmet crowded with other lights, and drains water and mud with its downward slant (Figure 10).

CONCLUSIONS. Piezoelectric ignitors are highly desirable for carbide lamps. Building them by modifying units intended for other applications is a pain, but can be done with ordinary hand tools. Since the Petzl ignitor now costs more than the SpeleoShoppe model, I may go back and try the Mixon-Minton design!

It seems a little surprising that someone is not selling a reflector with a piezo ignitor built in for caplamps. But when one considers the rapidly dwindling supply of caplamps (Premier is the sole survivor) and parts (tip cleaners are now in short supply), it makes business sense. The only new ideas in carbide lighting are for remote-generator units. This is testimony to Continental and British preferences and the huge market that Petzl enjoys.

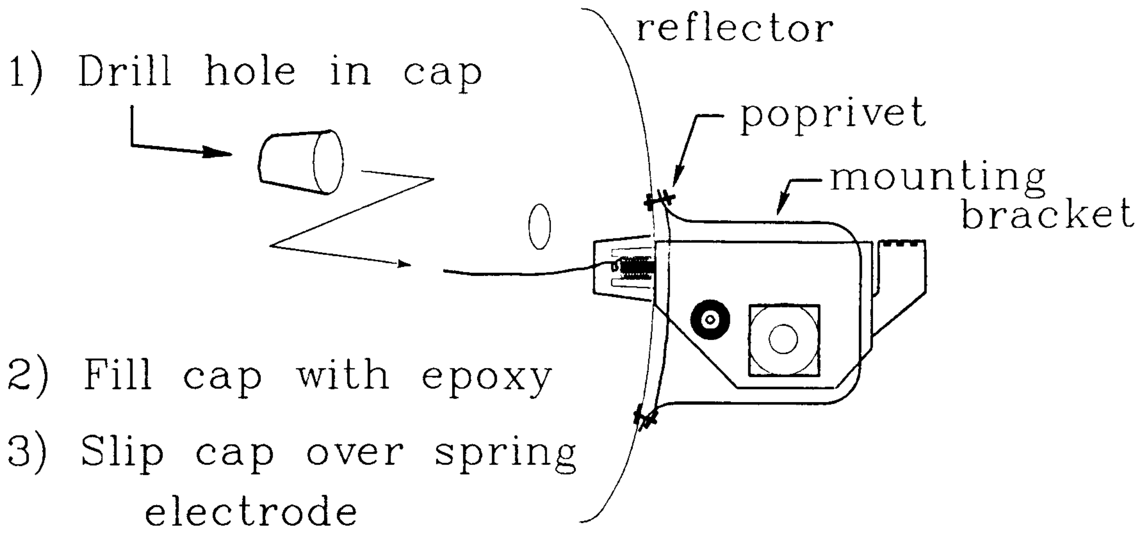

Fig. 6. Sealing the spring electrode against electrical shorting with a plastic cap and epoxy.

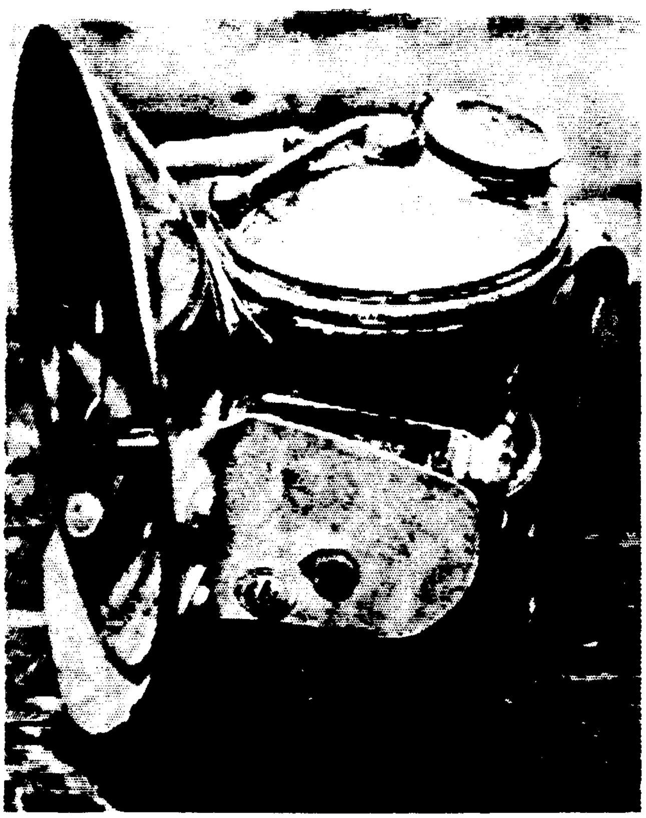

Fig. 7. The PLITER-87 in place on an Autolite Caplamp. Visor (bottom left) shields users eyes from long flames when the unit is mounted on the "Peak" fixture.

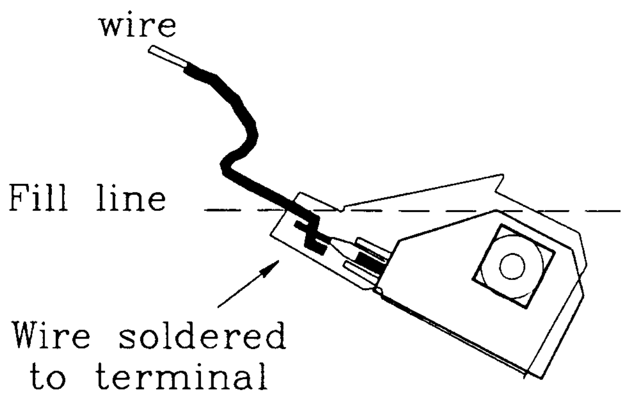

Fig. 8. Potting the piezo unit for use on the PLITER-88 design.

SOURCES

Bob & Bob, PO Box 441, Lewisburg WV 24901. 304-772-5049

The Speleoshoppe, P.O. Box 297, Fairdale, KY 40118. 502-367-6292

REFERENCES

Davis, Donald G. 1986. An Experimental Piezo-electric Lamp Lighter. Rocky Mountain Caving 3:2, Spring 1986, p. 11.

Davis, Donald G. 1987. Letter to J. Ganter.

Minton, Mark. 1982. Upgrade your carbide lamp with a Piezoelectric Ignitor. Association for Mexican Cave Studies Activities Newsletter #12, April 1982, pp. 52-54.

Mixon, Bill. 1981; 1982. The Electric Carbide Lamp. Windy City Speleonews Dec. 1981. Reprinted in the NSS News (Special Cave Lights Issue) 40:6, June 1982, p. 173-174.

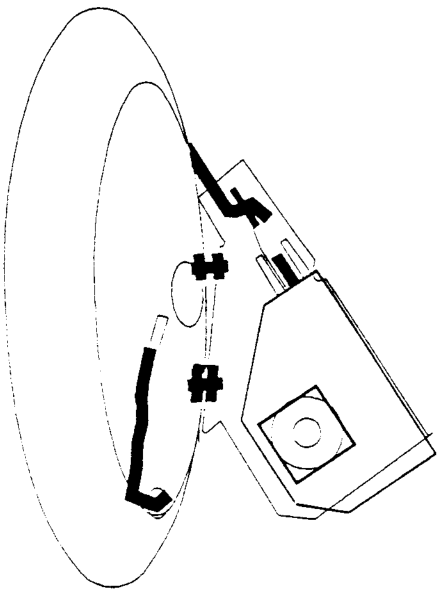

Fig. 9. The PLITER-88 showing rivet locations and wire routing.

<u>Ed note:</u> **Lowell Burkhead,** one of our members, manufactures piezoelectric lighters for carbide cap-lamps. The specially-machined plastic housing contains a replaceable piezoelectric element from a Scripto disposable cigarette-lighter. Lowell found that series resistance is necessary for optimum spark. Info for SASE:

Burkhead Machine Specialties
2611 Alderman Road
Springville, Iowa 52336

Fig. 10. The PLITER-88 in position. The tip cleaner (resting against reflector) is a British model consisting of two springs which screw apart to reveal the cleaning wires. It is available from the SpeleoShoppe.

-=

Rescue Communications:

FIELD-EXPEDIENT VHF DIRECTION-FINDER

A cheap and surprisingly effective VHF direction-finding method is the "body shield" technique. If your receiver is small (walkie-talkie or portable scanner size), you can place it in the center of your chest, and then rotate your body listening for the weakest and strongest signal. The weakest signal will have a sharp null when it is directly in back of you. This technique has a directivity (measured by me on an antenna range) roughly equivalent to a four-element Yagi beam, but lacks the gain and multipath rejection of a Yagi.

--**John Moore** NJ7E [rec.ham-radio]
[rec.ham-radio]

GPS UPDATE

(See "The Global Positioning System" by D. McClintock in SPELEONICS 11, p. 13.)

<u>Popular Communications</u> magazine, Jan. 1988 (p. 66) reviews electronic navigation systems (Omega, LORAN-C, etc) and says that the GPS program was delayed by the Space Shuttle disaster, but by the end of the year, 24-hour-a-day, 30-meter-or-better position fixes will be available with moderately-priced equipment. (There are presently only enough GPS satellites in orbit to provide service for approximately 8 hours per day.)

Early GPS receivers cost $20,000, dropping to $10,000 last year. A new Magellan(tm) handheld GPS navigation receiver costs $3000. GPS satellites transmit on 1575.42 and 1227.60 MHz. Civilian users will receive positions accurate within 30 meters. Present GPS receivers are giving accuracy within 3 meters when satellite positions ar

The article pictures the Magellan GPS receiver, which is only slightly larger than a calculator.

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NOTES ON BATS AND ULTRASONIC TRANSLATORS

[Excerpts from articles on rec.ham-radio, April/May 1989]

I BUILT AN ULTRASONIC RECEIVER

A magazine article rekindled interest in ultrasonics. February 1989 Popular Electronics featured an ultrasonic receiver construction-article. This was a superheterodyne circuit with a tuneable local oscillator. I ordered a kit of parts from Krystal Kits.

The kit consists of the printed circuit board, electronic components, PVC pipe and end caps (used as an enclosure). I bought a 3-3/4" Radio Shack piezo tweeter (40-1382) for use as an ultrasonic microphone, and supplied my own IC sockets, as none were furnished.

This Krystal Kit is nothing like a Heathkit. There are no instructions, just a reprint of the magazine article with a few hand-drawn corrections. Mechanical work, like laying out and drilling holes for the enclosure, remains the responsibility of the builder.

The printed circuit board eased construction, but was only of fair quality. There were extra splashes of copper, which required removal with an X-Acto knife. The holes for the mylar capacitors and several resistors were spaced too closely, forcing contorted bending of leads.

The oscillator was supposed to tune 15-35 kHz, but mine would only tune 12-21 kHz using the specified components. I substituted a 2200 ohm resistor for R5 (originally 15K) which expanded the tuning range to 15-66 kHz.

Only young listeners can hear pure sounds near or above 20 kHz. Using my ultrasonic receiver, I have listened to sounds I could otherwise not hear from these emitters:

Televisions and computer terminals
Older ultrasonic TV remote-control transmitters
Video cassette recorder
Metal detector search-coil

Although the receiver is sensitive, there are a few shortcomings: Moderately loud noises in the sonic range can leak through the receiver and be heard. Since the receiver is not shielded, it can detect some electromagnetic fields as well as acoustic signals.

In conventional radio receivers, the local oscillator generates a fairly clean sinusoidal wave. By contrast, the ultrasonic receiver uses a square-wave oscillator, which produces strong harmonics. Thus, you can hear harmonics of the same sound at more than one place on the tuning dial.

-- **Bob Parnass** AJ9S

BATRADIO

I decided to scrounge through my junkbox and build a BATRADIO. I preamplified 25-Khz narrowband ultrasonic transducer and passed the signal to a homebrew direct-conversion 25 KHz receiver. The receiver was a homebrew mixer and a Wavetek 111B (B as in battery powered) signal generator. The mixer output was lowpass-filtered and sent to a jambox for listening.

Austin has a rather unique downtown bat population living under the Congress Street bridge. At sundown the bats begin stirring and then, all at once, about 500,000 bats stop hanging around and start flying in one giant cloud. Bizarre! The BATRADIO worked great and I learned a lot about bat transmissions.

Later, after the bats had left the bridge, I drove home and set up the BATRADIO again. I detected one lone bat, somewhere in the dark chirping away.

Bat transmissions are FM/AM. That is, they are swept pulses, like a chirp, which is what they sound like when downconverted to the 'human band'. Sometimes the chirping is fast, sometimes slow. The bat on my street chirped slowly until a car drove by, then suddenly went to double the chip rate; presumably it had 'locked on' to the car. When the car went away, the bat resumed chirping at the slower rate. The bats seem to have an FM 'deviation' of 5 to 10 KHz. Since my receiver was only about 2 KHz wide at 25 KHz, I couldn't know exactly what the deviation was. My transducer was resonant, so it was not very useful to tune my local oscillator since the sensitivity fell abruptly outside the transducer's narrow passband. Anyway, it was an educational experience and the best VLF'ing I've done in a long time! Happy bat hunting.

Charlie Thompson WB4HVD Motorola Inc. Austin, Texas
--

I used to own one of those Hewlett-Packard ultrasonic receivers used by the phone company to locate nitrogen leaks. A pressurized line will hiss with ultrasonic frequency components. It was very directional and was a fixed-frequency superhet.

Some interesting things to listen to include:

1. Jingling of keys on your key chain. (lots of klangorous tones)
2. Scratching your 5 o'clock shadow with a credit card. (Amazing-- you could hear the ultrasonics from this 5 feet away.)
3. Scuba tank valve opened at 500 yards.
4. Our local bat population
5. Chimney sweeps (the bird, that is).

I am looking for a wideband ultrasonic microphone... I tested a cheap condenser mic which seems to work pretty well at 25KHz. The intended application is a tuneable ultrasonic receiver of the heterodyne/homodyne variety. Coverage up to 40KHz is desirable.

Charlie Thompson WB4HVD
--

Try one of those cheap electret pellet microphones, the kind built into small cassette tape recorders. Hand-picked ones are used as the element in a PZM. They are normally bandwidth-limited by the circuit they are used in, but I think they will actually respond well into the ultrasonic range.

Ben Thornton WD5HLS Video Associates Labs Austin, TX
--

In a small 1977 edition of their 'Pressure Transducer Handbook' National Semiconductor lists a pressure transducer recommended for audio use, p/n LX1701G or LX1701A, that they claim is good from dc to 50khz! I don't know if they are available now, (12 years later)?

William Martens
--

It's very interesting to listen through an ultrasonic translator while watching bats eat insects around an outdoor light at night. I've also listened to bats navigating cave passages; their chirp rate is slow in straight tunnels and becomes faster when they reach an obstruction or decision point.

-- **Frank Reid** W9MKV

When I was in Wind Cave in the Black Hills last year, the tour guide said that bats would not venture far into the cave because it was a maze cave and they would therefore easily get lost.

He said bats much prefer simple caves. By the way, the tour guide was one of the most knowledgeable I have ever met-- his command of geological knowledge was impressive.

John Logajan

--

I have listened to bat-radar in the past using...a signal generator at about 30KHz feeding a MC1496 balanced mixer, and using a range of different devices for receiving the bats (piezo tweeter, several ex-TV-remote-control ultrasonic transducers etc). Putting the output through a tuneable active filter swept by a scope timebase gives a crude spectrum display of bat activity...

Bats use a form of frequency modulation called LPM (Linear Period Modulation). For such a waveform, the instantaneous frequency is described by a hyperbolic function, as opposed to a LFM (Linear Frequency Modulation) where the instantaneous frequency is described by a linear function.

LPM signals have the advantage of being 'Doppler tolerant.' This means that regardless of the relative motion between the transmitter (the bat), and a target (an insect), the receiver (the bat, again) should always be able to accurately determine the target's range. This result can be derived from matched-filter theory. Check any elementary text on communication/detection theory.

Considerable research in the area of biological sonar was conducted throughout the 1970's. People were looking into how bats, dolphins, seals, and whales communicate and echo-locate. Many papers were published in the various IEEE journals, and in the Journal of the Acoustical Society of America (JASA). In particular, you may want to read

'Bat Signals as Optimally Doppler Tolerant Waveforms,' by Altes and Titlebaum; JASA, Vol 48, No. 4, Part 2, pp 1024-1020, 1970.

One paper shows a spectrogram of a call of a Weddel seal. The call was composed of several pulses whose correlation properties were similar to that of LPM; Doppler tolerance. Bandwidth was around 2 kHz. I don't know if anyone solved the 'crosstalk' problem. I would assume each bat uses a signal based on a slightly different hyperbolic function. That way he can detect on a signal that has his own particular 'signature' thereby ignoring any others.

David Drumheller KA3QBQ
Pennsylvania State University Applied Research Lab

--

I highly recommend the book Tuning into Nature [Philip S. Callahan (illus) 240pp. 1976 $10.00 ISBN 0-8159-6309-2 Devin]. Among other subjects, he shows that moth antennae are log periodic.

-- **Steve** N4RVE

A very good book relating to ranging and detection by living organisms, navigation and (synthetic) remote sensing is:

Localization and Orientation in Biology and Engineering, Ed. by D. Varju and H. U. Schnitzler, ISBN 3-540-12741-0 Springler-Verlag, 1984.

Some of the articles contained within the book on the subject of bat echolocation are:

The Performance of Bat Sonar Systems,

Control of Echolocation Pulses in the CF-FM-Bat Rhinolopus rouxi,

Echolocation seen from the viewpoint of Radar/Sonar Theory

David Prutchi 4X/HC1DT
Biomedical Engineering Program
Faculty of Engineering
Tel-Aviv University

-=-

CAVERS ON VIDEO

The CBS television series Rescue 911 documents famous rescues. The October 17 episode included the 1985 cave rescue at Spring Mill State Park, Indiana, where two people were trapped by high water. **Steve Clark, Sam Frushour, Dwight Hazen, Keven Komisarcik, Will Ott, Don Paquette, Karl and Denise Pitts, Frank Reid, Noel Sloan** and many other original participants (including victims) re-enacted it for the cameras last March.

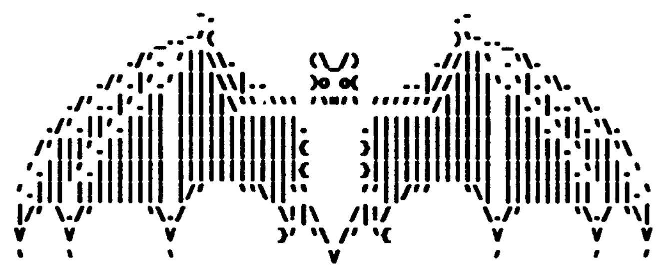
In all but the Eastern time zone, the program was preempted by news coverage of the San Francisco earthquake. Eastern cavers captured it on video tape. Cavers generally agree that it's well done; it even includes a scene of ham radio, which was invaluable during the actual incident.

I will copy the program for anyone who sends a VHS cassette in re-usable container with return postage. (NTSC only; I have no facilities for making video tapes in non-US formats.)

Your tape can also include a copy of Castleguard 1988 - Using a Cave Radio at Castleguard Cave, **Ian Drummond's** 20-minute video produced in cooperation with the Alberta Speleological Society and NSS Electronics Section. It shows Ian's 2-way SSB voice cave radio in operation at Castleguard (the famous alpine cave under a glacier in Banff National Park in the Canadian Rockies). It includes spectacular scenes from a helicopter (the only access to the cave in winter). The video was shown at the 1989 NSS Convention. In the future, it will be available from the NSS library, and the NSS Cave Video Committee plans to sell copies $20.

During my cave-radio trip to Florida (see p. 11), I saw **Wes Skiles'** video of the Australian cave-diving expedition where an entrance collapse trapped 13 cavers (see SPELEONICS 12). It's extremely professional and impressive, and will eventually be broadcast, perhaps on the Discovery cable-tv channel. --**Frank Reid**

-=-



It's been a good year for bats! This one was relayed by **Charlie Coleman** at NCR Corp., Columbia, SC (originator unknown).

New Products:

CASIO ALTIMETER WRISTWATCH

(by **Frank Reid**, with material from rec.aviation articles by **Terry Gold** and **Alan L. Peterman.**)

The Casio(tm) "Alti-Depth" watch (model ARW-320) contains an electronic altimeter which reads in 20-foot increments from -13120 to +13120 feet (or ±4000 meters in 5-meter steps). It measures water depth to 98 feet (30m). **Suggested retail price: $99.95, often found at $69.95.**

A solid-state pressure sensor enables this watch to use the International Standard Atmospheric relationship to approximate altitude. It displays altitude above sea level, or can be set to zero at any point for measuring relative altitude.

It is NOT set like a conventional altimeter: The barometer and altimeter are independent and do not interact; the user must set both.

The barometer reads ONLY in millibars, range 610-1050 mb. (One inch of mercury at 0°C = 33.8639 mb.) Americans may find millibars cumbersome at first, but the watch provides good motivation to learn metric units.

A user reports that a calibrated altimeter-test chamber revealed amazing accuracy: The watch was within 40 feet up to 13100 feet, which is better than government (TSO) requirements for aircraft altimeters.

I have not tried the underwater feature. The watch remembers the highest/deepest points since last resetting, and has presettable altitude and depth alarms.

The watch has a digital window below a 3-hand mechanical analog dial with ordinary setting-stem. Four large yellow buttons control the digital features. The pressure-sensor port is on the left side.

The digital display has 6 main modes: time/date, altimeter, barometer, depth, countdown, and stopwatch. The conventional time/date function has 24-hour mode. Time alarms are conventional. Countdown and stopwatch are independent. The countdown mode (presettable up to 24 hours) sounds a 10-second "beeper" upon reaching zero. The stopwatch has the usual "split" and "lap" features.

A few negatives: The analog hour-hand is hard to see and read. Only the minute hand is luminous. Amazingly, there is no light for the digital display. Upon engaging the altimeter or barometer function, it begins reading at 9-second intervals for the first 5 minutes, thereafter updating every minute. It will read on command by pushing a button, which also returns it to faster readings. Casio makes another altimeter watch with all-digital readouts, which costs about $20 more; examples at the local store had incomplete instruction books.

The instructions state (obscurely) that **the pressure sensor IS temperature sensitive.** Home experiments show an altitude increase of almost 300 feet (100m) when cooled from wrist temperature to 35°F (2C). An astute user can compensate adequately: Wear the watch for at least 20 minutes before setting altitude or pressure; in hot sunlight, shield the pressure sensor by wearing the watch on the underside of the wrist.

Overall, I love it! I now have a reasonably accurate altimeter for all occasions, including karst reconnaissance and pit caving. I expect that altimeter watches will be very popular.

--

KVH(tm) IMPROVED ELECTRONIC COMPASS

Electronic compasses have yet to prove themselves in cave survey. The Autohelm(tm) fluxgate compass (SPELEONICS 10, p.9) is reportedly tilt-sensitive (SPELEONICS 11 p.1). A more advanced device appears promising, were it affordable.

Ocean Navigator magazine, May 1989, advertized a new handheld electronic compass. The waterproof **KVH DataScope** has an internally-illuminated "heads-up" display visible through a 5 x 30mm monocular. Unlike the Autohelm, the DataScope's sensor is self-leveling for up to 20 degrees of tilt. The optics are gas-filled and hermetically sealed; the fixed focus could probably be compensated with an external lens for close range.

The DataScope also calculates range from apparent size of a target of known dimension. The rangefinder function is probably not useful in caving.

Resolution: 0.1°
Accuracy: ± 0.5°
Units: degrees or mils (user selectable)
Bearing display: 3 modes: instantaneous, averaged or continuous.
True north display: Yes. User enters variation.
Bearing memories: 9
Size: 4.5 x 1.7 x 2.4" (11.5 x 4 x 6cm)
Weight: 11.5 oz (327gm)
Temperature range: -20C to +70C
Power: 3-Duracell DL2025 3V lithium batteries
Battery life: 6 months to 1 year
Low battery: automatic indicator
Warranty: 1 year
Price: $455 suggested retail

More information: KVH Industries Inc.
850 Aquidneck Avenue
Middletown, Rhode Island 02840

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RADIO SHACK ELECTRONIC CAR COMPASS

(excerpts from articles on rec.ham-radio by **Robert Berger (N3EMO) and Frank Reid)**

Radio Shack's electronic compass ($49.95; catalog #63-641) uses an externally-mounted fluxgate magnetometer sensor. The display contains a compass card on a shaft-mounted magnet driven by two orthogonal coils. Demodulated signals from the sensor, corresponding to a direction vector, drive the coils. The backlit display uses incandescent lamps and innovative optics. The 5-conductor unshielded cable connecting the display and sensor is only 8" 20cm) long. It should be easy to extend. Power: external 12 vdc.

Compensation procedure is similar to that of conventional automotive compasses; point the vehicle sequentially N, S, E, W, adjust "N-S" and "E-W" trimmer resistors until the indication is correct.

The indicator disc is 1.25" (31mm) diameter, marked N-S-E-W with fat graduations every 22.5°. It's not a precision instrument, but is adequate for cars.

Most automobile compasses are unserviceable. Standard aircraft "wet" compasses won't work in steel vehicles. Directional gyros are impractical in cars; they require vacuum regulator, shock-mount, and manual adjustment (every few minutes) to agree with a magnetic compass.

Like a directional gyro, the fluxgate compass responds instantly with no overshoot. The indicator makes it easier to determine the direction to turn for a desired heading. [Quoting from instruction book]: "For example, if you are travelling north and want to go east, your electronic compass indicates that east is 90° to the right. A standard compass, however, rotates in the opposite direction of your turn."

The instruction book contains no schematic. The device is well-made inside, containing five IC's (including voltage regulator) and 7 transistors. The sensor is a toroid core with toroidal winding plus two other orthogonal windings over the outside, housed in a plastic box 1" x 1" x 3/4" (2.5 x 2.5 x 1.9cm).

Radio Electronics magazine, November 1989, describes a computer interface for the Radio Shack compass, and has a partial compass schematic.

--

VISIBLE CW LASER DIODES

Continuous-wave infrared laser diodes (e.g., those used in Compact Disc [CD] players) have been available for several years. Visible-light versions are now being manufactured.

From an article on sci.electronics (November 1988):

From NEC (Nippon Electric Corporation) preliminary data sheet for NDL3200 AlGaInP laser diode:

Typical performance at T_a=25°C

Operating Voltage	2.3 V
Optical Output Power	3.0 mW
Threshold Current	90 mA
Operating Current	100 mA
Peak Emission Wavelength	670 nm
Vertical Beam Angle*	35°
Lateral Beam Angle*	7°

* full angle at half maximum

Application note LEA-1011 describes APC (automatic power control) and protection circuits. The note's 1985 copyright date indicates that it was written for use with IR CW laser diodes. However, the NDL3200 seems quite similar to the older IR devices. Laser output power is sensitive to temperature (at constant drive current), therefore a PIN photodetector is included in the device. This is used in a feedback loop in the APC circuit to keep the output power constant. Careful circuit design is essential; it is apparently easy to fry these lasers.

NEC intends the visible CW lasers to be used in barcode readers and in pointers. Although they have a wide beam, it is easy to collimate.

1988 single-unit prices ranged from $260 - $500; Don Lancaster expects visible-laser diodes to reach the $5 range soon. See discussion and list of resources in Radio Electronics, October 1989, p. 65.

Solid-state laser gunsights the size of lipstick tubes are now available for aprox. $350. When the lasers become affordable, cavers may use them for aiming surveying instruments, or as signals and emergency lights. Light-beam communicators for pits could use either visible or infrared diodes (not necessarily lasers; see Radio Electronics magazine, July and August 1989).

--

WAVEBOX 100 Synthesized Frequency Source

Range: 1 Hz to 100 kHz. Output is dialed directly on thumbwheel switches.
Resulution: 1 Hz
Accuracy and Stability: 0.001%
Outputs: 20v p-p sine wave with ± 10vdc offset, also TTL/CMOS square wave.
Total harmonic and non-harmonic distortion: < -40 dB
Power: 115 VAC
Price: $325.
Manufacturer: Teledata Systems
68 Reservoir Rd.
New Milford CT 06776
ph: (203) 355-8285

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Resources:

SKY SPORTS
2900 Kanuga Rd.
Hendersonville, North Carolina 28739
orders: 1-800-AIR STUF
info, catalogs: (704) 693-3383

Aircraft instruments and accessories, specializing in miniaturized equipment for ultralights. Many devices adaptable to cavemobiles, including a good selection of high-quality altimeters,

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Cole-Palmer Instrument Co.
7425 N. Oak Park Ave.
Chicago, Illinois 60648
1-800-323-4340

Chemical/ biological/ environmental/ water-quality lab equipment and portable instruments; data loggers, safety equipment, ultraviolet lamps. HUGE catalog. Said to be individual-friendly.

--

From dnfel@uunet.uu.net on cavers' computer-mailing list, 6 September 1989:

REI sells lithium batteries for $20 a pop but they won't give me the name of the supplier...

Suppliers of lithium cells and batteries:

Panasonic Industrial Co.
Battery Sales Division
One Panasonic Way
Secaucus, NJ 07094
(201) 348-5266

SAFT America, Inc.
Lithium Battery Division
107 Beaver Ct.
Cockeysville, MD 21030
(301) 666-3200

Tadiran Electronic Indust.
40 Seaview Blvd
Port Washington, NY 11050
(516) 621-4980

Duracell, Inc.
Technical Sales and Mkt.
Berkshire Industrial Park
Bethel, CT 06801
(800) 431-2656

Rayovac Corporation
601 Rayovac Drive
PO Box 4960
Madison WI 53711-0960
(608) 275-4692

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From: **John Halleck** <NAHAJ@CC.UTAH.EDU>

This news item appeared in computer newsgroup COMP.RISKS. Note the effect on magnetic north.

Date: Tue, 9 May 89
From: **Brian Randell**, Computing Laboratory, University of Newcastle upon Tyne <Brian.Randell@newcastle.ac.uk>

A colleague drew my attention to an article in Radio Communication (v.65, #5, May 1989). Below I excerpt from the article, without permission.

THE GEOMAGNETIC STORM OF 13 MARCH 1989

Ted Harris and David Kerridge, Geomagnetism Group, British Geological Survey, 29 March 1989.

"The largest magnetic storm for 40 years started at 2am on 13 March 1989... The intensity of the storm was such that the aurora borealis (northern lights), normally restricted to high latitudes, was seen clearly in the south of England, and there were reports of observations of the aurora in Italy and as far south as Jamaica.

"The rapid changes in the geomagnetic field during the storm induced voltages in power lines, transoceanic cables, and telephone and cable TV networks...

"Ionospheric disturbances caused disruption of radio communications and resulted in the loss of TV reception in some areas. Satellite communications were also affected - as were satellite orbits as the increased ionospheric density produced extra drag.

"The increased radiation at high level created such potential hazards that a Concorde airliner on a transatlantic route took a more southerly flight path to avoid subjecting its passengers to radiation. Astronauts aboard the the space shuttle 'Discovery' would have been prevented from working outside the space craft because of the danger. The shuttle mission was recalled a day earlier than planned because of computer malfunctions which could have been caused by the storm.

"At sea-level, **North Sea exploration companies reported that 'down-well' instruments, used to steer drill heads, had experienced violent swings in compass readings of up to 12 degrees!** A Norwegian geophysical exploration company reported that all surveying has been halted after receiving warnings of the storm and its severity from GRG. The director of operations reported that two navigation systems used to fix the position of survey ships, which were in agreement prior to the storm, were now diverging. GPS (Global positioning system) satellites experienced increased drag which retarded their orbits so much that positional accuracy at the Earth's surface was lost. ...

"Solar activity is likely to peak during 1990 (Solar Maximum), resulting in more magnetic storms and a generally high level of magnetic activity over the next two years at least."
--

An article in Sky & Telescope magazine, October 1989, p. 426, includes graphs of compass disturbances during recent magnetic storms. The one for 13 March 1989 shows a 2-degree change in 10 minutes. -- ed.

UNDERWATER CAVE-RADIO BATTERY MANAGEMENT

Frank Reid

Cave-diving safety requires multiply-redundant equipment. An underwater cave-radio transmitter needs two independent sets of batteries, for reasons discovered during a recent trip to Northern Florida.

Kelly Brady and other divers used electric scooters to take the transmitter and antenna (in underwater housings) 1000 feet (300m) into Little River Spring, against strong current at water depths of 80-100' (25-30m). Since each minute spent at such depth requires about five minutes of decompression, the divers could not stay for the allotted 30-minute transmission. They left the transmitter and retrieved it the next day.

Time constraints and a shortage of divers would have forced us to abandon a second important radiolocation, had the transmitter needed to be returned to the surface for battery replacement. The next morning, however, the six-volt lantern batteries were still good! The divers were able to stop for five minutes at the second point on their way out. We knew the second surface location closely, having measured from the first, and already knew the depth, so a five-minute transmission was adequate.

I had not considered decompression factors. It will be easy to add a second battery and selector switch to the underwater housing, so that the unit can have a fresh battery without returning to the surface. Simplicity and redundancy make dual batteries preferable to timers.

(Speaking of which, **Peter Ludwig** reports that Austrian cavers equipped a cave-radio transmitter with a six-month timer. They planted it in an alpine cave in winter [the only time the cave can be entered, when flood water is frozen], then received it the next summer after the snow had retreated and the surface was navigable.)

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                    EARTH
            /         |         \
       smog          rope          bricks
      /               |               \
AIR - dynamite  -   CAVES  -  carbide  - FIRE
      \               |               /
    soda water       scuba         tequila
            \         |         /
                    WATER
```

[after original idea by **Kenneth Arromdee** on sci.physics, 30 January 1989]

Computer-newsgroup material reproduced in SPELEONICS is from "usenet," part of an international network of interconnected computers running the UNIX operating system. All such material is public domain.

LOW-NOISE ELF (ULF-RANGE) E-FIELD PREAMPLIFIER

John R. Wright *
KA5YWH/1SUN/800ULF

In my earlier article "Transmitting and Receiving at Ultralow Frequencies" (Northern Observer #4), I brought up the question of front-end noise and possible ways ways to minimize such noise in an ELF receiver operating at 983 Hz. In particular, I did not like having a 10 M resistor and its associated thermal noises between the receiver's antenna terminal and ground. There is obviously much room for improving this simple ELF receiver.

An article published by W. K. Gruber in the Watkins-Johnson Tech Notes (1983) treats, in part, the design problems of ELF preamplifiers. Gruber's article is an excellent reference on the subject of ELF receivers. Unfortunately, the preamplifier design described in the article is not appropriate for E-field receivers since it is intended to accept a 50 Ohm signal from a loop antenna. On inspecting the preamplifier circuit one notes that the secondary of the input transformer is 600 ohms reactive, which, with the additional 600 ohms in series, approximates the 2000 Ohm noise resistance (Rn = Vn/In) characteristic of the OP-27 low noise operational amplifier. The object is to have the input impedance as reactive as possible since thermal noise power is reduced in a smaller Ohmic resistance.

For E-probe applications, the TL071 low noise operational amplifier is a better choice since its noise resistance is near 2 M, and it can achieve a lower noise figure than the OP-27 (for the TL071: Vn = 18 nV/Hz and In = 0.01 pA/Hz; both values are for 1 kHz, which is virtually 800ULF's operating frequency). The accompanying circuit labeled "E-PROBE PREAMP" shows an acceptable TL071 configuration for a high impedance input. The two spark coils in series have an inductive reactance of about 550 K at 983 Hz, which is a fairly good match to the TL071. Assuming a temperature of 25 C (298 K), the solution of the noise figure equation for the above values yields 0.2 dB! Also, the Ohmic resistance of the two coils in series is only 26 K, a substantial reduction from 10 M, this less noisy. This 26 K Ohmic resistance will be the main source of noise in the receiver.

To test the preamplifier, I applied a low voltage 983 Hz signal to a wire running under my carport, about 6 ft above ground. The signal to this wire was keyed with a relay; however, there was also a 30 ft segment of wire between the relay and the source. The receiver, fed from a rigidly mounted 3 ft whip antenna, was located on the hood of a car parked about 50 ft from the transmitting wire. The geometry and transmitted signal strength were thus kept constant in these receiver comparisons.

With just the receiver described in my previous article, the A1-keyed ID was easily heard, along with 60 Hz interference, when the gain was high enough that front end thermal noise was also plainly audible. I estimated S/N at $/1. The 10 M resistor was then shunted with two spark coils (arranged in series). On increasing gain to compensate for the impedance decrease, two things were evident: 60 Hz interference was substantially attenuated and the 983 Hz S/N was improved.

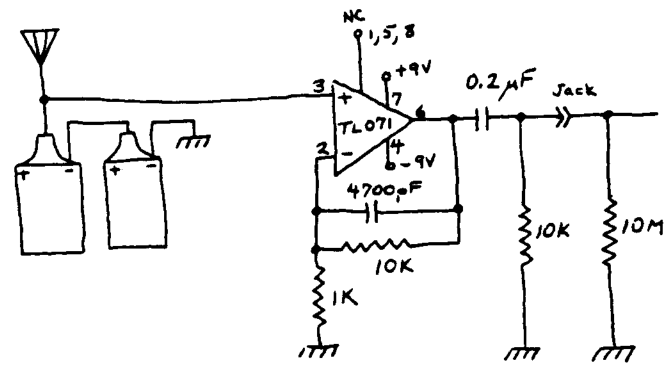
Then, with the E-probe preamplifier between the antenna nd the receiver (as shown in the circuit diagram, with the two coils now located at its input), a further S/N increase was experienced, along with the previously-noted attenuation of 60 Hz interference. In this case, gain increases brought up the A1-keyed signal, but it was now riding on the continuous tone radiating from the wire segment between the relay and the source, about 90 ft away! The continuous tone could be made strong, so that there was little contrast between it and the A1 part - the same effect one obtains with WWVB when gain is varied manually.

Clearly, the TL071/spark coil circuit enhances the 983 Hz receiver's sensitivity. The attenuation of 60 Hz interference is simply due to the spark coil's much lower inductive reactance at that frequency.

NOTE: Shielding is critical, and the audio output (speaker or headphones) must be as far as possible from the antenna, else positive feedback will set the circuit into oscillation (but controlled feedback allows a degree of bandpass narrowing). The receiver also needs a counterpoise, and I found that bringing my own body into electrical contact with the chassis was sufficient. The op amp feedback resistor can be as low as 2.2 K. At extreme gain 60 Hz interference is still a nuisance, but one is working with a significantly lower noise floor.

--

E-PROBE PREAMP:



This article reprinted from Northern Observer #7 (early February, 1989).

See previous articles by Wright in Speleonics 7.

* Box 4181, Station A, SEOSU
Durant, Oklahoma 74701

EXPERIMENTAL HEART TACHOMETER

Danny L. Britton KB4TEP *

The circuit uses three electrodes on the chest, one in the center and one on either side. The center electrode is used as a reference point and is tied to battery common. This electrode was added to help eliminate false triggering.

The TL082 is a dual JFET operational amplifier with high input impedance and low leakage. The 0.1 uf ceramic capacitor further isolates the patient from any DC current path: Low DC currents can induce microshock to the heart, especially when there are open wounds and needles have been introduced into veins. (Microshock can theoretically occur whenever a potential difference great enough to cause a current of over 10 microamps through the patient.)[1]

The 5-megohm resistors and 1N003 diodes reference the + inputs to common. I chose 1N4003 diodes for their high forward resistance below turn-on. These diodes protect the sensitive JFET op amps from any static discharge.

The TL082 op amps are connected as voltage followers. The following first stage of the LM324 is used as a differential op-amp with R1 R2 and R3 R4 setting the gain. The output of this stage goes to an impedance divider with the lower frequency passed on the second stage of amplification.

The second and third stages of the LM324 are configured as low-pass amplifiers. The third stage of the LM324 is used as a low level detector. Its output is used to drive either the LED or piezo element. Most of the parts are available at Radio Shack. Battery drain is aprox. 6 mA in the untriggered state.

The two units that I built are isolated so that no possible current can pass between the controls and the patient. The unit has been cave tested on a healthy patient and works fairly well. False triggering occurs when the patient moves excessively. I welcome any improvement to this circuit.

Reference:
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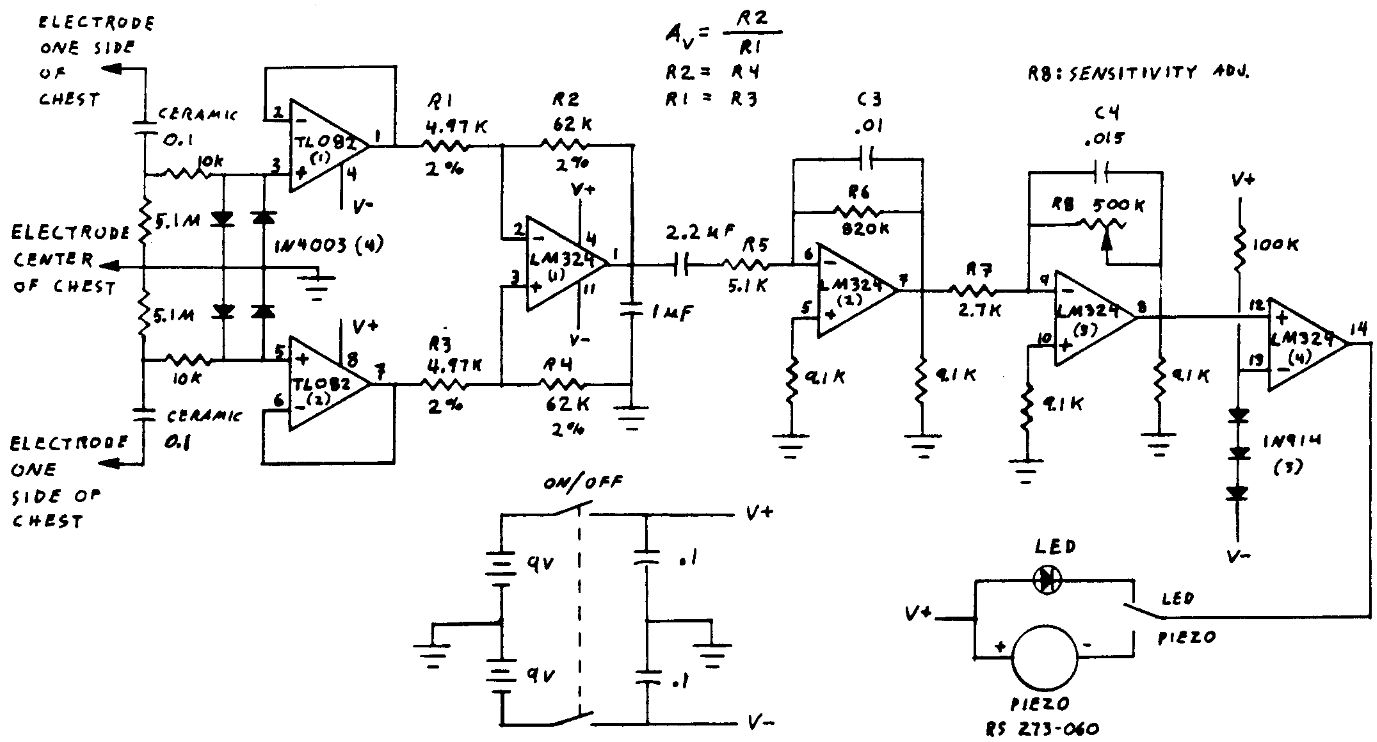
1. Carr, Joseph J. <u>Servicing Medical and Bio-electric Equipment</u> Tab Books No. 930.

* 5033 Laurel Wd Dr.
Knoxville, Tennessee 37921



ALTIMETERS FOR CAVERS

Frank Reid

Altimeters are useful for karst reconnaissance, other surface navigation, an aid to VHF/UHF radio operation, and as portable barometers.

Cave mappers seldom use altimeters, since level-survey is more accurate. Barometric and chimney-effect cave winds, venturi effects, etc. may cause altimeter errors inside caves. Magnitudes of such effects are largely unknown and should be investigated.

Procedure for altimeter survey: Set the instrument to known elevation at a benchmark, return to the benchmark at the end of the survey and note the difference between initial and final readings, then apply corrections assuming linear barometric change during the survey.

"Pocket" altimeters range in cost from $12 to $200 (see REI and similar catalogs). Most can be read only to the nearest 100 feet (30m). Precision surveying altimeters readable to the nearest foot are large, delicate and extremely expensive.

An aircraft "sensitive" altimeter (Figure 1) with 20-foot graduations can be interpolated to the nearest 5 feet. It requires no external connections when used on the ground. The user turns the knob to set prevailing barometric pressure, shown in the window on the right side; the altimeter should then display true elevation above sea level. (Conversely, setting the altitude hands to known elevation displays the sea-level pressure.)

Some aircraft altimeters display pressure in both metric and American units: 1000 millibars = 29.53 inches of mercury ("Hg) at 0°C. One standard atmosphere in the aviation context is 29.92"Hg (1013 mb) at 15°C. Actually, the pascal is the metric unit of pressure: 1 pascal = 1 newton/square metre. Hectopascals and millibars are equivalent. The USA is one of the few nations still using inches of mercury; the UK uses millibars for aviation altimeters and for general weather forecasting (but the UK still measures altitude in feet).

The aircraft altimeter in my "cavemobile" is good for predicting VHF radio range (given knowledge of average terrain), as a barometer (for weather prediction during cave expeditions and conventions), for predicting engine performance (about 5% of maximum power is lost for every 1000 feet [300m] of density altitude [also a function of temperature]), and as a navigation instrument in Western U.S., using aeronautical sectional charts as road maps. I set the instrument when passing airports, radio tower bases, or other known elevations, or get the barometric pressure by radio. (Elevations marked on city-limits signs of Western towns tend to be erroneously high, especially in ski areas.)

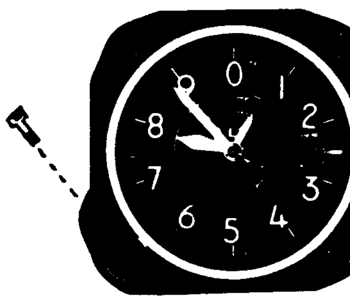


Fig. 1. Aircraft altimeter. To calibrate, remove front screw and side pin (some models), then pull knob outward.

Barometric variations can change indicated altitude by more than 500 feet (1/2 revolution) overnight, especially when a weather front passes. A common mistake is resetting the 100-foot hand to known elevation by the shortest path, without heeding the 1000-foot hand. Doing so can introduce a 1000-foot error.

Used/surplus altimeters are somewhat rare because of skydivers' demand. I have found serviceable units at hamfests (regional gatherings of amateur radio operators) for $25-40. Used instruments from government-certified repair facilities cost $125 to $200. "Encoding altimeters" are more expensive, and contain electronic interface for altitude-reporting radar transponders (for which there is no known caving use).

An altimeter with a "sticky" needle is not necessarily defective. Aircraft altimeters have built-in frictional damping to keep their needles from swinging wildly due to vibration. An altimeter not mounted in a running vehicle should be tapped gently with the fingers before reading.

Note: Aircraft altimeters are delicate! A 1-meter fall onto a hard surface will do more than $100 damage. For portable use, I protect mine with a neck lanyard and a foam-rubber beer can insulator.

ELECTRONIC ALTIMETERS. **John Ganter** found the Ultimeter(tm) electronic weather-station/barometer/altimeter unsuitable for caving (<u>Compass & Tape</u> v.5 no.2 Fall 1987 p.44). Electronic pressure-sensor improvement continues: Altimeter/barometer digital wristwatches have proven serviceable; see <u>New Products</u> column in this issue.

Speleo-meteorology references:

White, Thomas. NSS Caving Information Series #6: A Micro-Velocity Anemometer.

Went, F.W. "Measuring Cave Air Movements with Condensation Nuclei" <u>NSS Bulletin</u> v.23 no.1 (Jan. 1970) p. 1.

Pattison, Graeme. "Cave Air Flow Detection" Speleonics 10 (v.2 #2) p. 15.

RECALIBRATION (once per year):

Remove the screw on the front of the instrument near the pressure-setting knob (Fig. 1).

On Kollsman(tm) altimeters, this screw releases a nearby screw or pin on the side of the instrument. With pin removed, the setting-knob can be pulled outward like a watch stem, which disengages the altitude hands from the barometric scale. To calibrate, coincide known elevation and pressure readings, then push the knob back in and replace the pin and screw.

Other altimeters lack the side pin. The threaded hole which held the front screw is in a moveable plate; put a pointed object into the threaded hole and push it radially away from the center of the knob, allowing the knob to be pulled outward. Calibrate the instrument as described above, re-center the threaded hole and replace the front screw.

Calcium cell offers the armed forces a safer charge

The armed forces may soon be using a more reliable battery in their equipment

ISRAELI researchers claim to have developed a powerful battery for the armed forces that is safer than the lithium batteries they currently use.

The military need strong batteries to operate equipment from remote locations for very long periods. These batteries need to be able to be stored for many years, because it is often difficult to get equipment through to isolated units. Such batteries are many times more expensive than the ones used in domestic appliances because they have to be able to operate under a wide variety of temperatures, ranging from subzero arctic conditions to the sweltering tropics.

Until now, the armed forces have mainly used lithium cells, which can explode and damage expensive equipment if they short-circuit. Emmanuel Peled of Tel Aviv University and his colleagues have developed a cell based on calcium which he claims is safer than lithium cells.

Researchers in several countries have tried to develop calcium cells but, until now, have not developed cells that can be stored for more than three months, because the calcium corrodes. Military specifications require batteries that can be stored for several years. Peled and his colleagues have extended the life of a calcium cell to three years by adding barium and strontium salts to the electrolyte.

He says that calcium cells have a power capacity similar to lithium cells, and that his calcium cells are slightly lighter. The calcium cell can also operate between −40 °C and 200 °C. Peled says that the cells could be commercially available two years from now and will cost about the same as a lithium battery of comparable size, about £30.

Because of their cost, the new batteries are most likely to be used in military equipment, but they may be used in civilian applications that need high operating currents such as portable computers and flash guns. Also, the broad range of temperatures tolerated by the batteries means that engineers could use them for telemetry equipment in oil drilling heads, where the temperatures are high enough to melt lithium cells. □

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