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"BETTER CAVING THROUGH ELECTRICAL STUFF"

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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.

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Foreign subscriptions can be paid in U.S. "paper" dollars in the mail; an international money-order may cost as much as the subscription. 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.

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----- COVER -----

Linda Neslop's drawing of Ian Drummond with 115-kHz voice SSB cave radio, during tests at Jewel Cave, 1988. Linda's cave art has often appeared in the NSS News. See **SPELEONICS 5** for description of Ian's equipment.

The "ultimate cave-rescue vehicle" pictured on last issue's cover has been identified as a LAV (Light Armored Vehicle) made by General Motors, in electronic-warfare configuration.

Editorial

The skill with which a cave line-survey has been performed is frequently judged by the closure error of loops within the survey.

The advent of cave radio locations at many caves is providing a more stringent test, as it is now possible to relate the cave survey closely to ground features and hence to the topographic map of the area. When reading a compass, it is not adequate that the readings be repeatable, or have high precision; they must also be accurate.

Accuracy requires not only skilled operators and correctly adjusted compasses, but a knowledge of the local magnetic declination. In short it is advisable that the compass be calibrated near to where the survey is being performed. In this issue two approaches to this problem are explored. One solution uses the latest satellite technology, the Global Positioning System; the other uses a centuries-old method. Both have the potential to help produce more accurate cave maps.

--Ian Drummond

NEWS AND ANNOUNCEMENTS

BCRA ELECTRONICS NEWSLETTER RECEIVED

Congratulations to the **British Cave Research Association Cave Radio and Electronics Group** upon publication of their first newsletter! The 13-page Autumn, 1988 issue includes plans for a voice cave radio, Hall-effect magnetometer, photoflash slave unit, and several other articles.

BCRA CREG has shared with us their computerized cave-electronics bibliography, which uses PAPER-BASE, a very easy-to-use database program designed especially for bibliographies, which stores references as ordinary ASCII files.

The quarterly newsletter cost 2 Pounds Sterling (about \$6) for four issues. For more information, contact:

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UNITED KINGDOM
--

1988 NSS CONVENTION REPORT

Approximately 45 people attended our fourth annual Electronics Session. Three papers were presented (see abstracts in SPELEONICS 10).

Dave Larson demonstrated the Autohelm^(tm) electronic fluxgate compass. Dave also demonstrated a pair of single-wire cave telephones which he acquired in New Zealand (see SPELEONICS 4).

Gary Taylor spoke about Gates Cyclon cells, an advanced form of "gel cells" which have superior qualities making them especially attractive for caving applications.

Duke McMullan demonstrated an inexpensive ultrasonic rangefinder, and presented the circuit used in his hardhat covered with blinking LED's: An LED with internal blinker circuit will blink additional LED's in series-- Duke's hat has a 9-volt battery connected to eight parallel sets of three various-colored LED's in series, with one blinking LED in each series string.

Jim Basinger showed cave radios of Ray Cole's design (SPELEONICS 3) which were professionally built for Jewel Cave National Monument, but were not yet in working order.

Don Lancaster spoke about new and inexpensive electronic components applicable to cave instrumentation: Pressure transducers, LVDT interface chips, floating-point A/D converters, IC accelerometers, and the M50734 CMOS microprocessor. See Don's "Hardware Hacker" column in Radio Electronics magazine, August 1988, p. 69. Don also demonstrated the engineering and graphic powers of

POSTSCRIPT software, which is especially interesting to newsletter editors.

Max Carter spoke about Binary Phase-Shift Keying, a data-transmission method with which he has sent low-speed ASCII data for more than 1000 miles, using a one-watt transmitter and 50-foot antenna on the 1750-meter band (see Max's article in The Lowdown, July 1988, p. 18, which references his previous articles.

The membership voted to grant Ian Drummond's request for \$200 for editing video tape recorded at Castleguard Cave, demonstrating cave radio. All incumbent Section officers were re-elected.

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BIOLOGISTS TO USE CAVE RADIO

At the NSS Convention, two biologists requested cave-radio information; they intend to use cave radio in Hawaiian lava-tube caves, to identify individual trees whose roots penetrate the passages. The caves are only about 25 feet deep; they may be able to use the enhanced avalanche-beacon configuration described in SPELEONICS 10.

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AUTONELMtm ELECTRONIC COMPASS GETS BAD REVIEW

Roger Bartholomew presented test results of an Autohelm in his paper at the NSS Convention cartography session, in which he concluded that the Autohelm is unsuitable for cave survey because of its sensitivity to tilt-- 0.4 degree of pitch or roll yields a one-degree azimuth error. More sophisticated fluxgate compass sensors have magnetic cores which float in a dense liquid; these are claimed to be self-levelling up to 5 degrees of tilt. See Don Lancaster's "Hardware Hacker" column in Radio Electronics magazine, December 1988, p. 33 for a discussion of the fluxgate's operating principle, a circuit for experimenting, and other information of interest to cavers.

--

NEW MAP OF WIND CAVE CORRECTED FOR RADIO SURVEY

A multitude of rangers and cavers at Wind Cave National Park have been instrumental in publishing a new map of the cave, showing 51 miles (82 km) of passage. The old map sold at the visitor center shows 46 miles (74km). The new map was produced with the aid of computer programs SMAPS and AutoCad, and contains 25 radiolocations as constrained points for loop-closure purposes. The new map is available from the Wind Cave Natural History Society, Wind Cave National Park, Hot Springs, South Dakota 57747, for \$6.00.

--

CAVE RADIO AT JEWEL CAVE EXPEDITION

Paul Wightman and Frank Reid brought cave radio equipment to the Northwest Cave Research Institute (NCRI) expedition at Jewel Cave National Monument, South Dakota, the week after the NSS Convention. Fifteen cave-radio locations were done at depths to 360 ft (110m). NCRI plans a total of 75 radio-locations in the 76-mile (122km) cave system, in a project spanning the next two years. The radio-locations will be used for map calibration, similar to the method used at Wind Cave.

Interference from surface power lines made some radiolocations unusable; NCRI will prepare a power-line map to help plan future cave-radio operations. Summer atmospheric noise was tolerable before noon but became intense with afternoon buildups of cumulonimbus clouds over the Black Hills.

Surface-to-cave signalling told underground parties when data gathering was complete, saving appreciable time on trips where multiple radio-locations were made.

Ian Drummond and Frank Reid compared the performance of 114 kHz and 3.5-kHz cave radios at Jewel Cave, where strong directional anomalies were encountered at both frequencies near the elevator shaft and a steel-lined horizontal artificial tunnel. The tests were incomplete because Frank's transmitter failed. A new transistor from a local TV shop repaired it in time for the expedition. No anomalies were encountered away from the "improved" areas of the cave.

Several cavers who used cave radio for the first time at Jewel Cave plan to build innovative designs of their own. We anxiously await their results!

----- LETTERS -----

Dear Frank,

WAY back in Speleonic 2, The Communications Standard #1.0 of the Eastern Region of the National Cave Rescue Commission was (re)published. This was the "standard" two-pin Jones plug, available at Radio Shack, et al, set up with the wide prong negative and the narrow prong positive for general-purpose power supply connections for a variety of 12VDC equipment. It so happened that SAR folks in New Mexico have been using those plugs for a number of years, but with the wide prong positive. This presented a mild quandry, as I wasn't about to redo my entire setup (since I'm more likely to need them out here (West) rather than back there (East), yet I might easily encounter the other polarity of plug.

A voltmeter with a plug would tell me what I had, but it's a little awkward to drag around. Here's what I finally came up with:

Take one of the male inline plugs (RS 274-201 or eqv.), gut it, remove the cable clamps, and solder to the terminals a 330 ohm resistor and a "bipolar" (tricolor) LED, RS 276-012 or equivalent. This is the type with TWO leads -- not three. Set it up so that when it is plugged into the polarity that's proper for YOUR equipment, the LED glows green, and when the polarity is wrong for YOUR equipment, it glows red.

Mount the components so the shell will fit over the resistor and LED, with the LED sticking partly out the hole. Solder. Place the shell over the components. Test again. Make SURE it's working properly. Pot the components in epoxy, silicone

sealant, Shoe Goo II or cave mud. Enjoy.

It takes only a moment to insure that a plug has the right polarity: Correct, it glows green; incorrect, it glows red; AC, it glows yellow; nada, it doesn't glow; 800V, it makes a bright flash, a loud pop and a bad smell.

Actually, a dedicated voltmeter with a male Jones plug is nice to have around to keep an eye on the system voltage: it'll tell you when you need to run your engine for a little while. If you're feeling ambitious, the meter box could have additional circuitry to beep at you if the battery gets too low. QUESTION: What is the appropriate trigger voltage?

Unnecessary caution: Always put FEMALE plugs on your power SOURCES. ALWAYS.

Duke McMullan N5GAX NSS 13429R
Sandia Grotto
e-mail: ee5001ae@charon.unm.edu

--

Dear Frank,

I was at the Lowfer Convention and had a ball. I built a little direct-conversion Lowfer-band receiver a little bigger than a pack of cigarettes... It worked really good, especially on a Burhans active whip which Mitch Lee loaned me... Made a potentially useful discovery-- my beacon, which is FSK'd, can be heard through the noise much more clearly than if it were straight keyed carrier. That tone shift just makes it pop right out of the noise. According to my "earball" calibration, it's probably worth a good 10 dB in copyability.

I have an idea on measuring depth on a VLF induction "radio." If the transmitter output is regulated precisely, then depth can be measured indirectly by measuring field strength, without the need for triangulation techniques. However, you do have to be over the top of the transmitter or in some known geometric relationship to it. Will underground formations alter field strength enough to screw up the depth measurement? I believe not, but I don't know for sure.

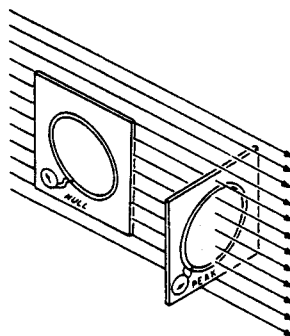
Dave Johnson
713 Texas Ave.
Los Banos, CA 93635

--

Dave Johnson is a 1750m experimenter and designer of metal detectors. He writes a regular column about radio below 10 kHz in Herb Balfour's Northern Observer newsletter (see Speleonic 10, p.15).

APOLOGY: Part of Dave Johnson's letter, and some other letters, were misplaced and could not be found at publication time. --Frank Reid

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HRUSKA'S WHEEL ANTENNA

by Joe "The Mole" Hruska (NSS 20253)

Here are details of the "wheel" antenna that I displayed at the 1986 NSS Convention.

Operating frequency	3580 Hz.
Overall diameter	0.419m 16.5"
Coil diameter	0.406 16.0
coil height	0.025 1.0
coil thickness	0.006 0.25

Construction materials :

- 1 nylon BMX-bicycle-style wheel minus metal parts
- 2 plexiglas(tm) disks to cover axle holes
- 1 bubble-level mounted inside axle hole on plexiglas disk
- 10 brass screws to attach plexiglas disks
- 1 plexiglas cutout to mount between the spokes
- 3 brass nuts, bolts and washers for mounting cutout
- 1 Radio Shack project box used as junction box
- 4 brass screws to replace junction box steel screws
- 2 brass bolts, nuts, and wingnuts to connect to primary
- 1 0.039uF 500V Sprague "Orange Drop" capacitor
- 1 tube clear silicone caulk (similar to bathtub caulk)
- 1 can PlastiDip (something like liquid rubber)
- 2 rolls of cloth medical tape 1.5 inches (4 cm) wide
- 2" (5.1 cm) of soft clear plastic tube, 5/16" (0.8cm) internal dia.
- 20" (51 cm) of soft clear plastic tubing 1/16" (0.16 cm) internal dia.
- 225 turns (1000 ft. or 228 m) of 18 AWG (0.102 cm dia.) magnet wire as secondary windings.
- 3 turns of 18 AWG (0.102 cm dia) magnet wire as primary.

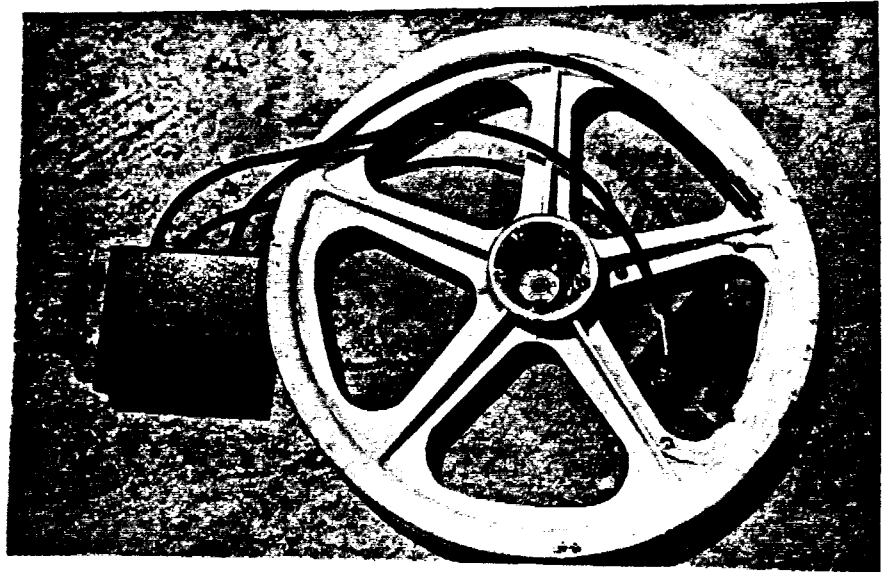
Construction Details.

No steel parts are used, to avoid corrupting the magnetic field. Brass and plastic are used throughout.

The bubble level is mounted on one of the Plexiglas disks which are then used to seal the hub of the wheel. Silicone caulk is used to ensure a watertight seal under the disks and in each screw hole.

The cutout is mounted between the spokes and the junction box is attached using the brass bolts, which will also serve double duty as the primary-winding terminals. The junction box is connected to the valve-stem hole using the larger plastic tube and lots of silicone caulk. The four wires which run through this tube are insulated from each other by pieces of the smaller plastic tube.

The three-turn primary winding is made first. Then, before the secondary windings are added, both small plastic tubes for the secondary are put in place so the outer end can be fed down to the junction box. The secondary winding is wound in layers with care to prevent scratching the thin insulation and to avoid high voltage potentials



between adjacent wires. The layers are wound to minimize air-gaps. After all winding is done, the wire nearly fills the channel of the wheel rim but does not protrude. This is desirable to protect the soft wire from damage (the wheel takes all the blows).

The coil is first covered with medical tape wrapped a few times around the circumference of the coil in the same direction as the wire was wound. This first wrap should overlap the edges of the rim a little. The second wrap is applied in a spiral around the thickness of the rim with lots of overlap on each turn. The spokes are somewhat annoying during this wrap. Cloth tape is used to provide a rough surface for the PlastiDip to adhere to. PlastiDip is available in liquid and spray form. I pour the liquid into a trough and dip the edge of the wheel in it. After rotating the wheel slowly to cover the entire taped area, a brush can be used to touch-up holes and thin areas. Two coats of PlastiDip seems to be enough.

The capacitor connected to the secondary windings was selected for best transmitted power. I used a turn of wire connected to an oscilloscope as a receiver to measure relative transmitted power when selecting the capacitor. Once the capacitor is finally installed, taking good care to keep the two ends of the primary well isolated, the junction box is half-filled with silicone caulk to insulate all vital connections.

The antenna is used for transmitting only, at a frequency of 3.580 kHz. The 12 volt battery delivers 1.9 Amps during operation, but actual power to the antenna is not known, nor is the "Q" of the antenna. The coil is rugged and small enough for transport in most caves. It has four very convenient hand-holds and can be levelled in seconds.

This antenna should work underwater with modifications to the wingnut connections. No high voltages are exposed and everything is watertight. To be safe though, I would rather use fewer windings of larger wire in an underwater unit to reduce the voltages produced.

THE MENDIP RESCUE ORGANIZATION (MRO) ANTENNA

by Brian Prewer.

The MRO cave radio is based on the South Wales Caving Club design by Bob Williams and Ian Todd. The design was published in "Caves & Caving" No 35, Spring 1987, p 1-7, (this article was reviewed in Speleoneics 7, p16).

The details of the antenna are as follows:

Size 1 m x 1 m square.

Coil is fabricated from 64-conductor ribbon cable.

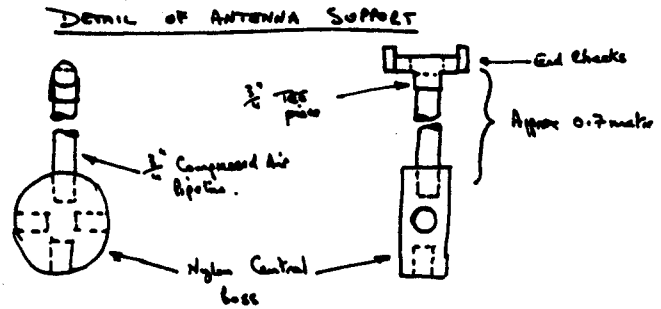
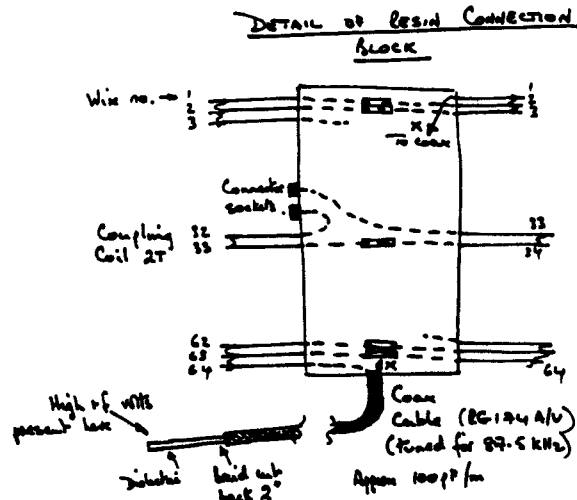
(Ed note, probably 28 AWG or 0.32 mm dia conductors)

The supporting frame is made of 3/4" (1.9 cm) dia. ABS compressed-air pipe. The central boss is made of nylon. (see sketch).

The whole assembly packs away into a small tackle bag which houses the support arms, coil, central boss, and connecting cable to the transmitter.

The antenna is used for both transmitting and receiving voice communications, and is tuned at 87.5 kHz by a specific length of miniature coaxial cable about 1 m long. Power input is 10 watts.

The main disadvantage of this antenna is the number of turns required thus making the whole assembly rather clumsy. The ribbon width is 4" (10.2 cm) and requires a fairly stout support frame. The joining of the ribbon cable is done (very tediously) by direct soldering and sleeving and finally moulding in a clear epoxy resin, with the tuning coax. cable being wrapped around the resin block. Two small sockets are set into the resin for connection to the primary winding. The whole thing should be waterproof. Soldering and moulding the whole connection area in a block of resin appears to be the best method in view of the high RF voltages present and the amount of mud and moisture likely to be encountered. So far, there have been no problems with this system.



THE ASS "GIANT" ANTENNA

by Ian Drummond

The Giant antenna was built to provide voice communication at extreme range (300 m + depth) with the ASS cave radio. (see Speleoneics 5 for circuit description of the radio). Once deployed, it cannot be moved or rotated and so cannot be used for location work, except as the transmitter antenna.

Size 13 x 13 m square; Operating frequency 115.4 kHz. The antenna is used for both transmitting and receiving.

Components :

- 52 m of 18 AWG (0.102 cm) 2-conductor, multi-strand, plastic-insulated wire.
- Metal junction box.
- Polarized 2-pin locking plug and socket.
- Small neon bulb and 150 k resistor.
- Selection of 630 v silver-mica capacitors about 1-4.7 nF.
- Amidon "E-core" or 18 mm pot-core.

