

speleonics 8

summer
1987

"BETTER CAVING THROUGH ELECTRICAL STUFF"

volume II number 4

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SPELEONICS 8

Volume II, No. 4, Summer 1987

SPELEONICS is the quarterly newsletter of the Communication and Electronics Section of the National Speleological Society. 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, \$6.00 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.

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Foreign subscription 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.

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** are mailed 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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EDITORIAL

Much effort has been expended by cavers in trying to locate underground passage by the method of electrical resistivity. The effort has been both mental and physical. The mental effort arose from the disappointing results; the simple model of a uniform earth pierced by circular cave passage did not work very well. Hence more complex models were developed, none, it must be said, overwhelmingly successful. The physical effort required arose from dragging cables, power supplies and other equipment through the bush to inject electrical currents and measure voltages.

Since the early days of cave-hunting by resistivity, the geophysicists have greatly improved both the models for interpretation of data and the methods of measuring resistivity. Many of the new methods are electromagnetic in nature and do not require the awkward equipment and cables of the old current-injection methods. Unfortunately, the geophysicists are usually looking for areas of high conductivity (ore bodies), rather than areas of low conductivity (caves), so their methods may not be directly applicable to cave hunting. Even so, perhaps the time has come to reappraise conductivity as a method for detecting caves. The challenge is to adapt modern commercially-available equipment (which can be rented or borrowed, as well as bought) to allow reliable detection of cave passage.

--Ian Drummond

COVER

Danny Britton operates British MOLEPHONE underground voice transceiver at 1987 NCRC Seminar. Story on page 4.

1987 NSS CONVENTION ELECTRONICS SESSION REPORT

Ray Cole presented "Improving the Organ Cave Radio" (See *Speleonics* 3). **Frank Reid** presented "Improvised Telephones for Cave Rescue," followed by an unscheduled test report on the British "Molefone" (see this issue). Abstracts of Cole and Reid papers are in *Speleonics* 7. *Speleonics* will publish both papers pending further development.

Informal presentations:

Ray Cole discussed Mollicell™ rechargeable lithium cells (see *Resources*, this issue) and a micro-processor-controlled battery charger. **Gary Taylor** demonstrated the Portasol™ butane-fueled soldering iron, and **Frank Reid** showed a mobile microwave source which triggers radar detectors in nearby cars (see "Information wanted: Cavemobile Electronics," *Speleonics* 7.) Austrian caver **Peter Ludwig** reported that cave radio is very difficult to use in the alpine karst of his homeland because of rugged surface terrain and the extreme depths of the primarily-vertical caves. Peter's demonstration of his Unique Self-Climbing Ladder (*Speleonics* 4) was well received at the vertical session.

Business:

The planned cave-radio video taping session did not materialize. Production of a video for the NSS Library, on how to use cave radio, remains a goal of the Section.

31 people attended the session. 10 new members joined, 5 memberships were renewed, 24 newsletters were sold. Incumbent officers were re-elected.

LETTERS

We are fortunate to have a growing membership of LF/VLF enthusiasts from outside the caving community. Their expertise and insight continue to yield new ideas for cave radio. Below is a digest of correspondence from a designer of metal-detectors:

Dear Frank,

...You have confirmed several ideas I had about operation below 10 kHz. I am now trying to figure out if there is any application of your field angle graph to problems in pipe locating (an important part of Fisher's business). Usually the field from a pipe is concentric about the (horizontal) pipe, but there may be some configuration where your chart would be useful to us.

In basement-band communications apparatus, I am leaning heavily toward transmitting on frequencies 30 Hz removed from powerline harmonics, and using a local oscillator which is a multiple of the powerline. This produces an I.F. of 30 Hz, which makes it easy to build a narrowband system and to filter out the powerline noise. Unfortunately I do not yet have a receiver built, though I do have a transmitter at 8.192 kHz...

In reading through my issues of Speleonics 1 and 2 and your "Caveman Radio" article in 73 Magazine, it appears that the time is ripe for someone to declare a standard VLF frequency for induction-type communications and locating apparatus. There seems to be a consensus that frequencies around 3.5 kHz are best, and that 3.2768 kHz is easily obtained by dividing a standard timekeeping crystal. I have used this frequency myself in metal detector experiments, and believe that it would make a good standard frequency for underground communications and locating work. Unfortunately, the receiver must use a local oscillator of 3.300 kHz-- not easily obtainable by any combination of division and standard crystals that I have found. I hope that Statek (or another crystal manufacturer) can eventually be persuaded to stock 33 kHz as a standard item. Persuading them to do so will be easier if an "industry" standard for this frequency exists. So-- I propose that Mr. Frank Reid declare by fiat that the aforementioned transmit and local oscillator frequencies are hereafter Genuine Caveman Standard Frequencies.

The existence of this standard will obviously not preclude the development of other standards if a need surfaces, but the existence of this standard will bring about the availability of the necessary crystals so that the various people building equipment can produce compatible equipment.

Sincerely,

David E. Johnson Fisher Research Laboratory
1005 I Street
Los Banos, California 93635

--

Dear Dave,

Cavers are notoriously independent and will hate me if I dictate a standard! 3276.8 Hz is an excellent frequency, especially for countries with 50-Hz power, since it falls almost exactly between power line harmonics. Below is a list of known rigs, ranked by frequency.

Your expertise in metal-detector design must include many good techniques applicable to cave radio. For example, a 30-Hz i.f. has many advantages but how do you eliminate the image frequency, 30 Hz on the other side of the local oscillator?

Sincerely,

Frank Reid

--

Dear Frank,

Using a full quadrature mixer to obtain image rejection in a superheterodyne is very easy in a receiver that receives at only one frequency, or within a frequency band that is less than 1.5:1 from its highest to lowest frequency. It's easier than having to tune the RF stage and make it track the local oscillator, and it allows you to use any IF frequency you want (especially, low frequencies that allow you to get narrow bandwidth easily). The difficulty in using a full quadrature mixer in order to obtain image rejection is when you have to cover a wide range of frequencies-- for instance, in a voice SSB mixer where in order to cover a 300-3000 Hz (10:1) frequency range requires at least four phaseshift circuits (preferably six) in order to obtain good sideband suppression, and the circuits must be constructed of 1% precision components. For low frequency, ultra narrow bandwidth, high sensitivity receivers, the quadrature technique is vastly superior to conventional technique, in my opinion-- better performance and simpler construction.

Using a 30 Hz IF allows you to get narrow bandwidth cheap, and to easily eliminate power line harmonics. If you intend to actually hear a 30 Hz signal, you gotta rectify it (you do this anyway to drive the S-meter) and use the resulting DC signal to actuate a tone generating circuit of some kind. In our pipe locators we proportion both the audio magnitude and the audio pitch so that you have good sensitivity for weak signals and good proportionality on strong signals. It's very effective-- but you gotta watch out that the audio "display" doesn't work its way back into the receiving system. In a receiver with a total gain of a million or so, the latter is not a trivial problem.

If people will agree on transmitters that work on 3.2768 kHz, nobody has to agree on what crystal to use in the receiver, just as nobody has to agree to use an ultra-low-frequency IF.

Point of interest-- If a transmitter could be switched from 3.2768 to 3.323 kHz, or if the latter frequency was an "auxiliary" transmit frequency available from a different manufacturer or by special order, then a receiver utilizing a local oscillator frequency of 3.300 kHz could receive either of the two transmit frequencies by flipping a switch in the mixer to go from "lower sideband" to "upper sideband."

I understand your reluctance to declare a standard frequency, but perhaps someone else will take it upon themselves to establish a de facto standard. I can't be the one to do this since I have not actually built any caving equipment and have no definite plans to do so (though I wouldn't rule out the possibility of manufacturing something sometime.)

(LETTERS cont.)

I think that longwave voice communications (SSB) should, in the long run, be moved up into the 1750 meter band in order to minimize the possibility of running afoul of FCC regulations. Also, since there are quite a few legal experimenters in this

band, it'd make it easier to compare R&D notes and make joint use of more than one person's equipment.

David E. Johnson

Partial list of past and present cave-radio frequencies:

Freq.	Name	Designer	Country	Reference/comments
Continuous Wave:				
630.0 Hz (and others)		US Bur. of Mines	USA	Mine emerg. beacons
900 Hz		A. Delpy	France	Speleunca no. 17 Jan-Mar 85
1800 Hz		Ron Allum	Australia	Speleonics 4
2000 Hz		E. R. Roeschlein	USA	Electronics Sep 23, 1960
2000 Hz	MIDAC	Royce Charlton	USA	NSS Bulletin 28:2 1966
2000 Hz		Smith & Stevens	England	Trans. BCRA 1:1 Jan 74
3276.8 Hz	Troglograph	Mike Bedford	England	Electronics Today Internat' 1 May 86
3495.6 Hz	Organ Cave Radio	Ray Cole	USA	Speleonics 3
3500.0 Hz		Frank Reid	USA	73 magazine Feb. 84
7305.0 Hz		Richard Blenz	USA	unpublished; no longer used
38.4 kHz	Ogof Beacon	A. & A. Bell	Wales	S. Wales Caving Club Newstr #101
Voice/CW:				
baseband af		various		
32.768 kHz	M-85	Bo Lenander	Sweden	Speleonics 7
87.5 kHz	Ogofone	Williams & Todd	Wales	Caves & Caving Spring '87
102.4 kHz	Molefone	Bob Makin	England	commercially prod. (review: Splncs 8)
114.3 kHz	ASS Cave Radio	Drummond & Coward	Canada	Speleonics 5
125.0 kHz	Ogofone	Williams & Todd	Wales	Caves & Caving Spring '87

DECCA NAVIGATION SYSTEM INFORMATION

Frank Reid

Information request posted on USENET computer network:

How does the DECCA navigation system work? My understanding is that it's a British or European system similar to LORAN-A. There are several "chains" of transmitters 70 and 130 kHz. What is DECCA's range, coverage area, and signal format? I have seen no DECCA equipment advertised in marine electronics catalogs in the U.S. Is it used in the Western or Southern hemispheres? Is DECCA considered a modern system? Ian Fleming mentions it in "Thunderball," aboard the bad guy's yacht.

Frank Reid
reid@gold.bacs.indiana.edu

Unisgned reply:

As a technician who worked for Decca Marine for several years I can tell you a little about the Decca Navigation system. You are right about the frequency range. It is a continuous wave system where as LORAN is a pulse system. The transmitters (3 or more) transmit signal on a specific frequency and the receiver measures the phase difference between the signals. Each transmitter is on a different frequency, but they are locked to a frequency standard such as a cesium-beam clock. The Decca system is very popular in Europe, and is (claimed to be) more accurate than LORAN. But

Decca makes money by leasing the receivers to ships, and since LORAN is free, there is no market in the USA for the Decca system. I think there is a Decca chain on the east coast of Canada.

Also the system is not pure cw, some type of info is encoded but I'm not sure what. (The techs from the UK told us about a European fellow who decided he was going to get rich, he designed a digital receiver that used the Decca system. The Decca receivers used big dials like analog clocks, kinda looked like the altimeters in old crashing airplane movies, the hands would spin wildly until it locked onto the signal. Anyway, this fellow's receiver worked real well and sold for the price of about a 6 month Decca lease. After many canceled leases the boys at Decca found out what was going on and they got one of his receivers, analyzed it and found that by slightly changing the signal the bogus receiver doesn't track anymore. But it didn't effect the mechanical works in a "real" Decca receiver.

[The above was printed in 1750 Meters: Western Update #46, July 6, 1987. Subsequent correspondence disputes the part about Decca's intentional interference with competing receivers. The different frequencies used in Decca chains are subharmonically related. The Decca chain on the east coast of Canada uses 114.3 kHz, the same frequency as Ian Drummond and Julian Coward's ASS Cave Radio (Speleonics 5). No interference has been reported.

