speleonics 8

summer 1987

"BETTER CAVING THROUGH ELECTRICAL STUFF"

volume II number 4

CONTENTS

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.

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.

Chairman (and editor of this issue):
Ian Drummond
5619 Dalwood Way NW
Calgary, Alberta
CANADA T3A 1S6

Secretary (and editor of the next issue):
Frank Reid, W9MKV
PO Box 5283
Bloomington, Indiana
47402-5283

Treasurer:
Joe Giddens, N5IOZ
PO Box 170274
Arlington, Texas
76003

Publisher
Diana E. George, N9DEJ
1869 Trevilian Way
Louisville, Kentucky
40205

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 MOLEFONE underground voice transciever 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 Molicell^{tm} rechargeable lithium cells (see Resources, this issue) and a microprocessor-controlled battery charger. **Gary Taylor** demonstrated the Portasol^{tm} 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 come 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	**Spelunca** 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'l** 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 Newsltr #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 advertized 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 continous 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 acurate than LORAN. But Decca makes money by leasing the recievers 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 reciever that used the Decca system. The Decca recievers used big dials like analog clocks, kinda looked like the altimeters in old crashing airplane movies, the hands would spin wildly untill 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.

BRITISH "MOLEFONE" UNDERGROUND VOICE TRANSCEIVERS TESTED AT U.S. CAVE-RESCUE SEMINAR

Frank Reid

The National Cave Rescue Commission (NCRC) was fortunate to have **Dr. John C. Frankland**, noted British cave-rescue physician, as an instructor at the 1987 week-long training seminar at Abingdon, Virginia. Dr. Frankland brought a pair of the **Molefone** underground voice transceivers which have replaced wired telephones for underground communication in most British cave rescues (see Letters, SPELEONICS 7). The units were lent by the manufacturer, and are the first Molefones ever brought to the U.S.

All who used the Molefones were impressed by their small size, light weight, ease of operation, durability and performance. We were disappointed that there were no accompanying schematic diagrams or technical specifications (other than those reproduced below), and that the units are plastic-encapsulated, thus nonrepairable.

Tests on the surface yielded intelligible voice range of 600-700 feet (183-213m), using 1-meter-square loop antennas made of 24-conductor ribbon cable. Horizontal or vertical polarization of both coils had little effect on range. One Molefone unit seemed to perform better than the other.

British sources tell us that Molefones operate at 102.4 kHz, single sideband. Range was limited by strong interference from the LORAN-C navigation system (100.0 kHz), and an even stronger unidentified low-speed data transmission of the type used by military communications systems. The test area lies midway between the two nearest LORAN-C transmitters, approximately 300 miles from each. LORAN interference (a rhythmic clattering sound) could be nulled by rotating the antenna but the data signal could not. An underground operator (aprox. 100 feet deep) reported that interference diminished only slightly inside the cave. There was minor interference near large power lines. During the approach of a thunderstorm, receivers detected static crashes from visible lightning. Molefones were not affected by a nearby handheld VHF transceiver. They were not tested near AM broadcast stations.

Despite interference, the Molefones performed well within minimum specifications. Audio quality was good, with no "Donald Duck" SSB sound. Female voices gave superior penetration of noise and interference.

Inexperienced people can easily operate Molefones. There are only three controls; on/off, push-to-talk, and a button which, when held down, transmits tone bursts for direction-finding. The tone feature was not useful, as its frequency is nearly the same as that of the interfering data signal.

The receiver automatic gain control (AGC) circuit seems to work exceptionally well, with the wide range, fast attack and slow release characteristics needed for good SSB reception. AGC makes direction-finding difficult, especially with strong signals, as it tries to maintain constant level through a null (the optional signal-strength meter was not included in the kit). The microphone amplifier also appears to have AGC, which is probably necessary but causes increased background noise pickup between words.

The equipment set included two handheld speaker-microphones and one boom-mike headset. The battery charger will charge four batteries simultaneously, and readily converts from 230 to 115-volt operation by changing transformer taps and wall-plug. The charger uses a common voltage-regulator IC, and incorporates an ingenious current-meter shunt as part of the printed circuit board.

Antenna and microphone/speaker are connected by 5-pin locking DIN plugs. No harm is done if they are accidentally interchanged (I did it!). The specially-made battery packs have standard Molex^{tm} connectors. Batteries should be removed when the units are not in use; it's very easy to accidentally switch them ON.

Of course, I tried to look inside the Mo-Fo's but their insides are filled with plastic foam, and no parts are visible. We assume the potting is for protection from water and mechanical shock...

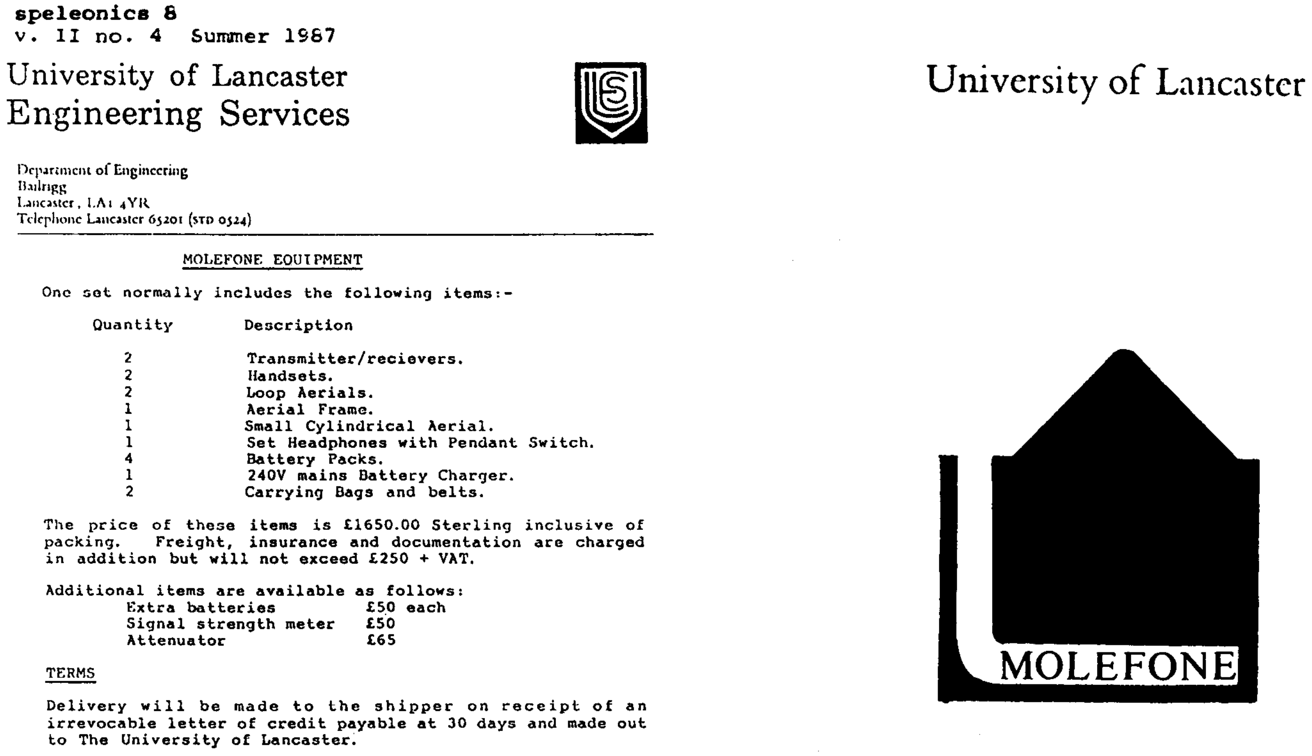
A Molefone transceiver with accessories and extra battery fits easily inside a small (.30-cal) ammo box. The underground antenna is spread on the cave floor; the surface unit has a folding plastic spreader which holds the loop in a rigid square. There is also a ferrite antenna which can be used in motion underground. It fits into very tight passages, and works underwater. The ferrite antenna has about 20% the range of the one-square-meter loops.

The 25 LORAN-C transmitters in continental US, Canada and Alaska (with 400-800 kW outputs) could make Molefones unusable in much of North America. Several new stations are planned for mid-continent. The LORAN-C transmitter nearest the British Isles is at Sylt, W. Germany.[1]

Had a digitally-tuned receiver of known sensitivity been available, we could have learned many technical details of the Molefone. Without test equipment, we were unable to verify the frequency of Dr. Frankland's units. If they are indeed at 102.4 kHz, then the interfering FSK signal may have been an image response or intgermodulation product of the Molefone receiver. Back home in Indiana, LORAN-C is especially strong but no other signal is detectable at 102.4 kHz, using an Icom IC-720 HF transceiver with Burhans VLF converter and Burhans E- and H-field antenna preamplifiers. Very strong signals at 88.0 and 134.9 kHz, with characteristics similar to the unidentified interference, come from U.S. Navy station NSS (!) at Annapolis, Maryland, 336 miles (540 km) from Abingdon.

Europe and North America, especially the U.S. East Coast, are crowded with very powerful transmitters between 10 and 200 kHz.[2] Designers should consider frequency-agile cave radios and receivers which, like the Burhans circuits[3], include special features to suppress spurious response (and thereby achieve greater gain).

America needs long-range voice "cave radios" for rescue application[4]. NCRC instructors and students who used Molefones agreed that they they are a superior and viable alternative to wired telephones underground. Most considered the problems of cost, nonrepairability and potential interference unacceptable but a few with immediate needs indicated an interest in buying them.



University of Lancaster
Engineering Services

Department of Engineering
Bailrigg
Lancaster, LA1 4YR
Telephone Lancaster 65201 (STD 0524)

University of Lancaster

MOLEFONE

MOLEFONE EQUIPMENT

One set normally includes the following items:-

Quantity	Description
2	Transmitter/recievers.
2	Handsets.
2	Loop Aerials.
1	Aerial Frame.
1	Small Cylindrical Aerial.
1	Set Headphones with Pendant Switch.
4	Battery Packs.
1	240V mains Battery Charger.
2	Carrying Bags and belts.

The price of these items is £1650.00 Sterling inclusive of packing. Freight, insurance and documentation are charged in addition but will not exceed £250 + VAT.

Additional items are available as follows:

Extra batteries	£50 each
Signal strength meter	£50
Attenuator	£65

TERMS

Delivery will be made to the shipper on receipt of an irrevocable letter of credit payable at 30 days and made out to The University of Lancaster.

(One British Pound Sterling equals approximately $1.60 US.)

Molefone Specifications

(Reproduced from instruction manual. The remainder of the 17-page booklet describes equipment operation, and standard methods of radiolocating and depth measurement.)

Size:

(Transmitter-receiver unit, excluding aerial)	150 x 100 x 75 mm

Weights:

transmitter-receiver and battery pack	950 g
additional battery packs, each	400 g
tape aerial and spreader	1250 g
cylindrical aerial	1057 g
headset	475 g

Power Supply:
Detachable battery pack. Rechargeable. 12 volts, 1/2 amp. hour capacity giving approximately 4 hours endurance under intermittent use.

Effective Range:
Normally up to 500 feet through rock and soil. In favourable conditions 1000 feet may be achieved.

General Detail:
System has facility for hand microphone and external speaker or hand-free operation using boom microphone and earphones. Transmission is simplex. Speech or alternatively a locating tone may be transmitted.

In the locating mode, the directionality of the system is such as to enable locations to be determined to within 1 foot plan position error at depths of up to 400 feet in favourable ground. Instrument case is normally water resistant, but a waterproof version (suitable for diving at up to specified limits) can be made available by the addition of a waterproof housing and specialized components.

References
----

1. Good, J.F. The Aviator's Guide to LORAN-C. Aksunai Press, Wakefield MA 1984.

2. Brault, C.E. VLF-LF Update. The Lowdown, April 1987, p. 15

3. Burhans, R.W. Active Antenna Preamplifiers. Ham Radio, May 1986 (reprinted in The Lowdown April 1987)

4. Amundsen, Chris. Search And Rescue Operation in McClung Cave. NSS News May, 1987 (46:5) p. 108

A SHORT BIBLIOGRAPHY OF ELECTRIC CAVE LIGHTING 1958-1987 (USA)

Bill Torode, NSS Librarian

SD = Speleo Digest, annual compilation of the best articles from NSS grotto (local chapter) newsletters. Available from NSS Headquarters, Cave Ave., Huntsville, AL 35810 (Some years' volumes are out of print).

1958

Varnedoe, Bill
Electric Lights for Spelunkers
NSS News 16:8 Aug 58 p. 82-83

1959

Hippenmeier, Louis
The Coming of the Monster
SD 59 p. 3-33
Florida Speleologist 2:1
Winter 59 p. 14

1960

Higgons, Alton
Nickel Cadmium Lights
SD 60 p. 3-23, 3-26
Florida Speleologist 2:2
Spring 60 p. 7-9

Patton, John M.
Modification of
Electrical Cave Lamp
SD 60 p. 3-4, 3-6
Baltimore Grotto News
3:3 Mar 60 p. 59-60

1961

Patten, John
A Simple Guide for
Electrical Cave Lighting
SD 61 p. 3-21, 3-34
Baltimore Grotto News
4:5 May 61 p. 74-76

Plummer, Bill
Electric Cave Lamp Reflector
SD 61 p. 3-18, 3-21
Baltimore Grotto News
4:6 Jun 61 p. 94-96

Varnedoe, Bill
A Convenient Headlamp
SD 61 p. 3-17, 3-18
Huntsville Grotto Nwsltr
2:1 Jan 61 p. 4-5

1962

Cronenwett, Bill
Flashlight Batteries for Caving
SD 62 p. 3-6, 3-8
Texas Caver 7:2 Feb 62 p. 9-11

Ludwigson, John
Seeing in the Dark
SD 62 p. 3-10
Cleve-O-Grotto News 9:4
Jul-Aug 62 p. 29-31

Plummer, Bill
Quantitative Comparison
of Cave Lamps
SD 62 p. 3-1, 3-5
Baltimore Grotto News 5:8
Aug 82 p. 184-188

Plummer, Bill
More Light from your Flashlight
SD 62 p. 3-8, 3-10
Baltimore Grotto News 5:9
Sep 62 p. 208-209

1963

Plummer, Bill
New Cave Lamp
SD 63 p. 3-72, 3-73
Baltimore Grotto News 6:10
Oct 63 p. 2-2, 203

Vaughn, Michael T.
(part 1) Electric Caving
(part 2) The Use of
Batteries in Caves
SD 63 p. 3-62, 3-71
GCG Electric Caver
1:1 Jan-Feb 63 p. 5-6
1:2 Mar-Apr 63 p. 13-17

1964

Harlan, Dave
Constructing an Electric
Light for Caving
SD 64 p. 3-90, 3-93
St. Louis Grotto Nwsltr 3:1
Spring 64 p. 6-9

1965

Heller, Warren
A High Illumination
Light Source
SD 65 p. 3-80, 3-82
Guacharo 6:2 May 65 p. 63-64

Patten, John
Idiot-Proof Battery Charger
Huntsville Grotto Nwsltr 7:12
Dec 65 p. 65-66

Rohrer, Tom
Carbide vs Electric Lighting
California Caver 17:1
Mar 65 p. 16-17

Sturrock, James C.
An Emergency Lighting System
SD 65 p. 3-82
Georgia Underground 2:1
Jan-Feb 65 p. 10

1967

Varnedoe, Bill
About Electric Lights
Huntsville Grotto Nwsltr
8:7 Aug 67 p. 123
8:8 Sep 67 p. 133
8:9 Oct 67 p. 144

1968

Bartholomew, Roger
Electric Headlamps & Batteries
SD 68 p. 3-21, 3-24
Texas Caver 13:4
Apr 68 p. 41-42

Budreau, Alan
Some Light-Source Notes
SD 68 p. 3-18, 3-21
Massachusetts Caver 7:1
Jan 68 p. 3-5

Cox, Roger
Electric Caving Accessories
and Improvements
Wisconsin Speleologist 7:2
Spring 68 p. 69-72

Cox, Roger
Cave Better Electrically
Wisconsin Speleologist 7:4
Fall 68 p. 122-124

Degenhardt, Eugene
Black Light in a Dark Cave
SD 68 p. 3-115, 3-116
Underground 11:2 Jun 68 p. 55-56

Feldstein, Len
Vented Nickel-Cadmium Batteries
SD 68 p. 3-24, 3-25
GCG Electric Caver 4:1 Jan 68 p. 8
4:2 Feb 68 p. 19

Peterson, Gil
Some Notes for Would-be
Electric Cavers
SD 68 p. 3-25
Wisconsin Speleologist 7:2
Spring 68 p. 67-69

Thrun, Robert
Comments on Flashlight Bulbs
Potomac Caver 11:9 Sep 68 p. 90

Uthoff, John
The Future of Electric Caving,
or, Carbide Cavers Beware.
SD 68 p. 3-29
Intercom 4:2 Mar-Apr 68 p. 19

Varnedoe, Bill
A Light Source Comparison
SD 68 p. 3-27, 3-29
Huntsville Grotto Nwsltr 9:11
Dec 68 p. 162-164

1969

Munthe, Jens
Ticklish Moments
(Why I Hate Carbide)
Caving in the Rockies 11:5
May 69 p. 87-89

1970

Ewers, Ralph
A Charger for Nicad Batteries
SD 70 p. 225
GCG Electric Caver 6:1
Jan 70 p. 2-4

1970

Tandy, Michael K.
Portable Electric Lights
SD 70 p. 226-236
California Caver
21:2 Jun 70 p. 37-47
21:3 Sep 70 p. 63-70
21:4 Dec 70 p. 89-94

Varnedoe, William W.
Some Engineering Characteristics of Small Portable
Electric Lights for Caving
(has bibliography)
NSS Bulletin 32:4 Oct 70 p. 71-87

1971

Tandy, Mike
Battery Chargers
SD 71 p. 274
California Caver
22:1 Feb 71 p. 15-17
22:2 Apr 71 p. 37-40

Tandy, Mike
Electric Headlamp
SD 71 p. 272-273
California Caver 22:4
Aug 71 p. 85-87

Knutson, Steve
Light for the Caver
SD 71 p. 272
Speleograph 7:3
Mar 71 p. 44-46

1972

Bartholomew, Roger V.
How Long Will They Last?
SD 72 p. 276-277
Texas Caver 17:4 Apr 72 p. 63
Reprinted: Explorer
Jun 81 p. 109

Cox, Mike
The High Efficiency,
Variable Electric Cave Light
SD 1973 p. 204-205
Cave-In 5:5 Sep-Oct 73 p. 3-9

Craig, Carl
Back-up Lights for Caving:
Some Notes for Beginners
SD 73 p. 210-213
Cascade Caver 15:1-2 76 p. 3-6
Huntsville Grotto Nwsltr 14:10
Oct 73 p. 104-107

Darilek, Glenn
Care & Feeding of Sealed
Ni-Cad Batteries
SD 73 p. 202
Texas Caver 18:5 May 73 p. 152

Darilek, Glenn
$1.00 Battery Charger
SD 73 p. 273
Texas Caver 18:11 Nov 73 p. 335

Geer, Richard P.
Series: Electric Cap Lamps
for Cavers. Part:
1: Introduction p. 4
2: Bulbs p. 11
3: Primary Batteries p. 19
4: Secondary Batteries p. 29
5: Battery Packs p. 35
6: Edison Batteries p. 45
7: Alkaline-Rechargeable
Battries p. 51
8: Lead-Acid Battery p. 73
9: Lead-Acid Caving Batt. p. 79
Michiana Caver 1:1-11 Jan-Nov 74

Gerhardt, Ralph D.
Extending Flashlight
Effectiveness
SD 73 p. 203
Texas Caver 18:7
Jul 73 p. 198-199

Sellers, Rich
Mine Spot Caving Light
SD 72 p. 260-261
Electric Caver 8:10
Oct 72 p. 98

Sproul, Alex
Caver's View of the
Eveready 565 Battery
SD 1972 p. 275-276
Huntsville Grotto Nwsltr 13:11
Nov 72 p. 96

Varnedoe, Bill
History of Portable
Electric Lights
Huntsville Grotto Nwsltr 14:11
Nov 73 p. 119-120

1974

Bartholomew, Roger V.
The Second Source
Texas Caver 19:8
Aug 1974 p. 122-123

Polizzotto, Gary
Self-Contained Helmet Lamps
Northeastern Caver 4:5
May 74 p. 55-57

Varnedoe, Bill
Lamps and D-Size Batteries
SD 74 p. 225
Huntsville Grotto Nwsltr 15:9
Sep 74 p. 96-97

Varnedoe, Bill
A Continuously-Variable
Light for Caving
SD 74 p. 226-227
Huntsville Grotto Nwsltr 15:10
Oct 74 p. 112-113

Varnedoe, Bill
Lamp Dimmer Measured
SD 74 p. 227-228
Huntsville Grotto Nwsltr 15:11
Nov 74 p. 122-124

Wallace, John
An Electronically Controlled
Cave Light
NSS News 32:12 Dec 74 p. 328

1975

Dyas, Mike
Spare Lamps
SD 75 p. 298-299
D.C. Speleograph 31:6
May 75 p. 13-14

Ellis, Ian
The rechargeable Alkaline
Battery - Inexpensive and
Overlooked
Karst Window 5:7
Oct 75 p. 56-58

Green, Dale
Ni-Cad Notes
SD 75 p. 299-300
Inner Mtn News 7:4 Apr 75 p. 18

Green, Dale
Self-Contained Hardhat Lights
SD 75 p. 298
Inner Mtn News 7:11 Nov 75 p. 55

Kunath, Carl
Electric Caving... One More Time
Texas Caver 20:8
Aug 75 p. 126-127

Larson, David
Fluorescent Cave Light
SD 75 p. 296-298
Windy City Speleonews 15:1
Feb 75 p. 4-6

Maegerlein, Stephen D.
Building a Battery Case for a
Cave Diving Light
SD 75 p. 293-296
Underwater Speleology 2:4
Aug 75 p. 31-34

Powers, John
Batteries: Today & Tomorrow
Subterranean Sun 5:7
Aug 75 p. 10-11

Sherborne, Bill
Handlights
Texas Caver 20:2
Feb 75 p. 20-22

Sturdwich, Richard
Lamps for Caving Systems
California Caver 26:2
Jun 75 p. 61

1976

Burns, John
Mobile Battery Charger
SD 76 p. 290-291
Subterranean Sun 6:10
Oct 76 p. 99-100

Cook, Tom
The Cheapo Underwater Light
SD 76 p. 285
Underwater Speleology 3:6
Dec 76 p. 58

Kaye, Tom
Electric Light Systems
for Caving
SD 76 p. 281-284
D.C. Speleograph 32:10
Oct 76 p. 1-6

Nehring, Don
Electric Caving
Michiana Caver 3:4
April 76 p. 29-30

Varnedoe, Bill
Lamp Beam Comparisons
SD 76 p. 286
Huntsville Grotto Nwsltr
16:8 Aug 76 p. 77-80

Yancey, Derald
A Variable Charger for
Ni-Cad Cells
SD 76 p. 285
Underground Express 2:3
Aug 76 p. 67

1977

Anonymous
Koehler Lamp Modification
Helps Cavers Change Bulbs
NSS News 35:10 Oct 77 p. 209

Crawford, Ed
A Survey of Electric
Caving Lights
SD 77 p. 301-304
Cascade Caver 16:4
Apr 77 p. 31-37

Dunn, Berney
Portable Charger (p. 61);
Simple Battery Charger (p. 62);
Cords, Plugs and Connections
(p. 62-63);
Bulbs (p. 64-65)
SD 77 p. 304-305
Underground Express 3:4
Nov 77 p. 61-65

Harmon, Dale
A Fluorescent Light
SD 77 p. 309
COG Squeaks 20:10 Oct 77 p. 77

Harmon, Dale
Batteries
COG Squeaks 20:10
Oct 77 p. 77-78

Johnson, E. Alan
Development of a Maintenance-
Free Caving Light
Georgia Underground 14:3-4
Jul-Oct 77 p. 237-239

Reynolds, Tony L.
Modifications on a Justrite
Karst Window 7:2
Mar-Apr 77 p. 23

Sumner, Ken
Koehler Wheat Lamp
Georgia Underground 14:1-2
Jan-Apr 77 p. 209-211

Smith, Ken
A Cheap Battery Recharger
for AA Nicads
COG Squeaks 20:6 Jun 77 p. 46-47

Varnedoe, Bill
Dimmer Circuit, Modified
SD 77 p. 308-309
Huntsville Grotto Nwsltr 18:1
Jan 77 p. 4-5

1978

Harmon, Dale
Some Data on Batteries
SD 78 p. 215
COG Squeaks 21:1 Jan 78 p. 6

Harmon, Dale
Data on GE 425 Bulb
SD 78 p. 244
COG Squeaks 21:1 Jan 78 p. 7

Harmon, Dale
Lighting
SD 78 p. 243
COG Squeaks 21:8 May 78 p. 23

Kaye, Tom & Ray Cole
Special Issue on Electric Caving
SD 78 p. 225-242
D.C. Speleograph 34:7 22pp

Lloyd, Hal
An Electric Standby Light
SD 78 p. 243
Cave Crawler Gazette 19:1
Spring 78 p. 13

Molter, Dan
Battery Charger
Cleve-O-Grotto News 24:6
Jul 78 p. 61-62

Pisarowicz, Jim
The New Tekna-Lite II
Virgin Passage 2:4 Mar 78 p. 4

Pisarowicz, Jim
Alternative Lights
SD 78 p. 213-215
Virgin Passage 2:6 Jul 78 p. 7

Powers, John
Wheat Lamp Tips
SD 78 p. 246-247
Subterranean Sun 8:3 Mar 78 p. 5

Sproul, Alex
An Affordable Electric Cave Light
SD 78 218-224
Brass Light #5 Jan 78 p. 52-61

1979

Barnes, John
Nicad Battery Charger
SD 79 p. 244
Kentucky Caver 13:1 Jan 79 p. 9

Harmon, Dale
Zener Diode Regulated
Battery Charger Circuit
SD 79 p. 274
COG Squeaks 22:1 Jan 79 p. 4-5

Geer, Richard
Rechargeable Batteries and Costs
Michiana Caver 6:7 Jul 79 p. 55

Hissong, Jack
Consumer Report
(Disposable Flashlights)
Electric Caver 16:3 Mar 79 p. 26
16:4 Apr 79 p. 42

Scheffram, Walter
The Sealed Cell Batteries
Michiana Caver 6:7
Jul 79 p. 60-64

Veni, George
Report: The Nova Light
Texas Caver 24:1
Jan-Feb 79 p. 10-12

Walden, Bill
Controlling that Electric
Cave Lamp
COG Squeaks 22:6 Jun 79 p. 49-50

Walden, Bill
Charging That Battery
SD 79 p. 269-272
COG Squeaks 22:9 Sep 79 p. 62-67

1980

Denbo, Donald W.
Do-it-Yourself Dimmer
for Bright Cavers
Speleograph 16:11 Nov 80 p. 102

Healey, Roger
Modifying Electric Light Systems
D.C. Speleograph 36:7
Jul 80 p. 24-25

1981

Brkich, George
Wet Cell Nickel Cadmium Batteries
SD 82 p. 250-251
Underwater Speleology 8:4
Aug 81 p. 40-41

Cook, Tom
ElChepo Diving Light no. 5
Underwater Speleology 8:2
Apr 81 p. 15-17

Kaye, Tom
Electric Light Systems
Caving Information Series
Huntsville, AL.
Nat'l Speleo. Soc. 1981 23pp.

Pope, Rick
The Dazzling Denbo Dimmer
Speleograph 17:2 Feb 81 p. 28:31

Reinbold, Tom
The Koehler 'Wheat' Cap Lamp
Texas Caver 26:4 Aug 81 p. 51-54
Reprinted: NSS News
Jun 82 p. 175-176

Saunders, Joe
Six Volt Waterproof Flashlights
Wisconsin Speleologist 17:3
Dec 81 p. 46-47

Zachariasen, George
A Rechargeable Battery for
Six Volt Lanterns
Wisconsin Speleologist 17:3
Dec 81 p. 47

1982

Jorden, Jay
Another Wheat Lamp Charger
Texas Caver 27:6 Dec 82 p. 107

Mueller, Dave
Care and Charging of Wheat Lamps
SD 82 p. 326
Cinter 24:4 Jul-Oct 82 p. 48-49

Berg, Norm
Electric Light Systems for Caving
NSS News 40:6 Jun 82 p. 170-172

1983

Seaman, Ed
A Review of Electric
Lighting Rigs
Windy City Speleonews 23:4
Aug 83 p. 56-57

Sims, Mike
A New Dimension in
Caving Batteries
Cal Caver 34:1 Spring 83 p. 5,8

1984

Mele, Gary
Compact Efficient Lamp Dimmer
Cal Caver 35:4 Winter 84 p. 38

Wilson, Forrest
Ni-Cad Battery Charger
Underwater Speleology 11:1 p. 1-2

1986

Fischesser, Mike
LRUES Light System
NSS News 44:9 Sep 86 p. 338-339

Ganter, John
The Speleo Technics FX-2 Lamp
NSS News 44:2 Feb 86 p. 43-45

Terrell, Rick J.
Krypton Bulb Adaptation for
the Justrite Electric Headlamp
NSS News 44:8 Aug 86 p. 311

1987

Jette, Joe
Halogen Lamps for Caving
Arizona Caver Feb 87 p. 3

THE PBR FLASH GUN

by Bill Baus

[Reprinted from Bloomington Indiana Grotto Newsletter 19:2 June 1987]

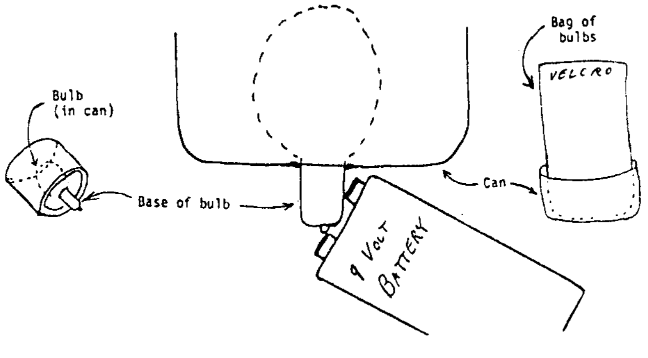
In cave photography, the need for a compact and powerful light source makes the M3 and M3B flash bulbs highly desirable. Unfortunately, the only flash gun for these bulbs still being manufactured is a unit made by Ron Simmons, which sells for $70. For those who want a more economical unit or who want a secondary flash unit, I highly recommend the PBR flash as the ultimate in compactness and economy.

MATERIALS REQUIRED:

1 can of Pabst Blue Ribbon Beer. (Other impact-molded aluminum cans will probably work, but you wouldn't have a genuine PBR flash.)

1 free 9-volt transistor battery from Radio Shack.

1 small cloth bag (preferably heavy nylon) with Velcro, drawstring, or button closure, large enough to hold a dozen bulbs and the battery, but small enough to fit into the beer can.



MANUFACTURING PROCESS:

1. Drink the beer.
2. Cut the can so that about 1-1/2 inches (4 cm) of sidewall remains with the bottom of the can. Discard the top.
3. Tape the edge of the can to prevent cutting yourself or your gear.
4. Make a hole in the center of the bottom of the can, just large enough to fit the base of an M3 bulb. It should fit tightly. Mash the edges of the hole so that there are no sharp places.
5. In case you make a mistake in cutting or punching the hole, start step 1 with a new beer. After 5 or 6 failures, however, I recommend delaying the manufacturing process until the next day unless you have help drinking the beer.

OPERATING INSTRUCTIONS:

1. Place an M3 bulb in the hole with the bulb on the inside of the can and the base on the outside.
2. Aim away from your eyes.
3. Place one of the snap-type terminals of the battery against the cylindrical base of the bulb (not the can) and tilt the battery until the other terminal comes against the contact in the center of the tip of the bulb base. The bulb will flash.

LONG-RANGE CAVE RADIO

Frank Reid

This article is revised and condensed from a booklet (same title and author) sold at the 1981 International Congress of Speleology. See references 1, 2 and 3 for detailed cave radio theory and practice.

Originally built in 1973, this equipment has an excellent service record and maximum detectable range of 600-800 m. Using parts values as shown, receiver gain is so high that layout, shielding and decoupling are critical. Alignment and operating procedures are somewhat complex, and some parts are difficult to obtain. These circuits are offered as reference material rather than as plans for new construction.

General Notes On Cave Radio

1. Power lines are the main source of interference. Strong 60-Hz harmonics (50 Hz in some countries) extend well into ultrasonic frequencies. Choose a frequency between two harmonics, and use a receiving filter sharp enough to reject the adjacent harmonics[7]. Such narrow bandwidths require precise frequency control and very slow Morse-code speeds. Reference 8 presents an ingenious solution to frequency-stability problems, using a swept-frequency transmitter.

My early equipment operated at 7300 Hz; Dick Blenz had gone to that frequency from 2000 Hz to escape power line harmonics. I later converted to 3500 Hz because of a fortunate coincidence of available parts. Performance improved significantly at the lower frequency; transmitter coil current was greater and, as predicted by Davis[6], atmospheric noise is less intense.

2. Atmospheric noise from thunderstorms can produce major interference in summer. It is strongest at night[6]. Atmospheric noise is polarized such that it nulls when the receive coil's plane is horizontal.

3. Receiver gain is limited by feedback from the output back to the antenna. Receiver gain can be enormously increased without feedback problems by using a **balanced mixer** and local oscillator to convert the input frequency to a different frequency, then filtering and amplifying that frequency, keeping the original signal at low level. Receivers using frequency-conversion require careful design to suppress image response.

4. Strong interfering signals can intermodulate with the desired signal in active filters, producing even worse interference. Active filters use power and produce noise. Although physically smaller, they are more complex than L-C filters of equivalent performance. L-C filters are easy to design from cookbook tables and are often the best solution for the high-performance filters required by cave radio receivers.

Transmitter Notes (see diagram)

1. R1 is a meter shunt (2 amps full scale). R2 is a voltmeter resistor (12 volts full scale).

2. Voltage regulator may be omitted if CMOS logic circuits are used.

3. Transistor types are noncritical. The final amplifier should be a high-current, high-frequency type. A 2N3055 or a power FET should work.

4. Large bypass needed here.

5. The keying circuit is essential: Pulsing the signal saves battery power and simultaneously increases range because the receiver operator can more easily discriminate a pulsed signal against background noise and interference. A low output on pin 3 keys the transmitter. The diodes in the keyer circuit (1N914 or equiv.) allow a greater-than-50% duty cycle (Electronics, June 21, 1973, p. 129). Keyer as shown pulses transmitter at 2 Hz, 10% duty cycle. Duty cycle was later raised to 20% for better performance with narrow receiving filter. Some designs derive the keying signal by further dividing the output frequency.[4]

6. The driver simulates a class-C amplifier. Once each cycle, the pulse from the 555 replenishes the energy lost in the resonant circuit. The duty cycle can be adjusted for either highest coil current or best efficiency. Duty cycle affects antenna tuning because a longer on-period lowers the coil's Q. Period is adjustable 20 to 70 microseconds. Final input power is 15 watts or less, depending on the antenna coil used.

See ref. 4 for an alternative design. There's much opportunity to experiment in this area; the complimentary outputs of the frequency divider could, for example, be used to drive a bridge-inverter final amplifier.

7. Crystal frequency is divided by 36.

8. Crystals in this frequency range are series-mode, and may not work in all oscillator circuits. I chose 126 kHz because the crystals were available, and because they work in both transmitter and receiver. C3 is as needed to trim crystal frequency.

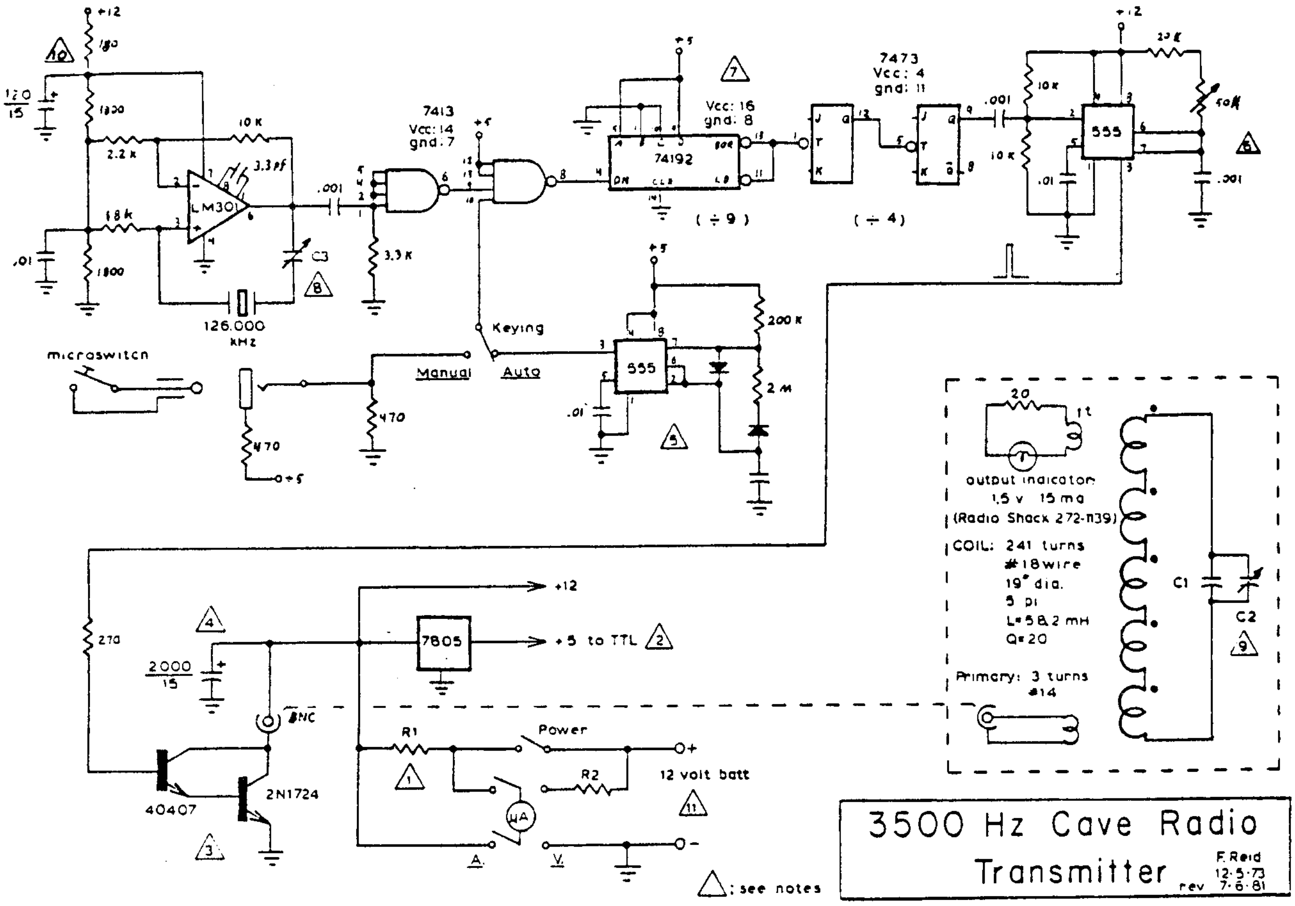
9. C1: 1500-volt mica, about .035 uf. Select carefully for resonance. C2: 200 pf or more, fine-tuning control. (Receiver-type variable capacitors cannot withstand high voltage.)

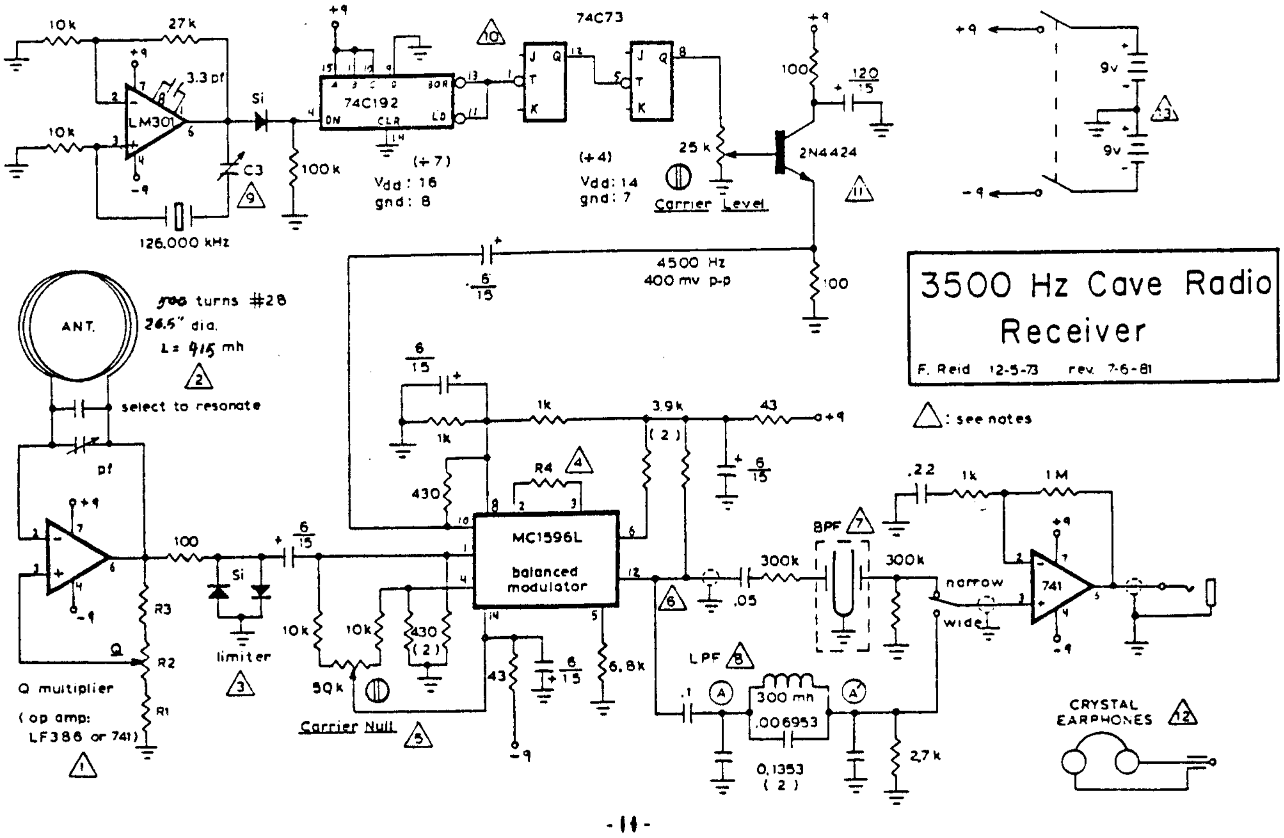
10. Decoupling network.

11. Use battery with low internal resistance; Ni-Cd or Gel-Cell.

Receiver Notes (see diagram)

1. The Q-multiplier has been a very successful cave radio circuit. It can be a transceiver all by itself. Any 741-type op-amp will work; low-noise types are preferable. The op-amp's negative-feedback loop forms a negative resistance which cancels the resistance of the coil. As the Q (regeneration) control is advanced, sensitivity and selectivity increase until oscillation occurs (infinite Q). The value of (R1 + R2 + R3) is not critical and may range from 10k to 1M. Choose R1 and R3 such that R2 provides useful control throughout its range. A large tuning capacitor is needed because Q affects resonant frequency.


3500 Hz Cave Radio Transmitter
F. Reid 12-5-73 rev 7-6-81
+12
180
1800
120/15
10 K
2.2 K
LM301
3.3 pf
18 k
.01
1800
C3
8
126.000 kHz
.001
7413
Vcc: 14
gnd: 7
3.3 K
+5
74192
Vcc: 16
gnd: 8
(÷ 9)
7473
Vcc: 4
gnd: 11
(÷ 4)
.001
10 K
10 K
.01
555
+12
22 K
50 K
.001
6
Keying
Manual
Auto
microswitch
470
470
+5
555
200 K
2 M
.01
5
7
270
4
2000/15
BNC
40407
2N1724
3
7805
+12
+5 to TTL
2
R1
Power
R2
12 volt batt
11
1
µA
A
V
20
1t
output indicator
1.5 v 15 ma
(Radio Shack 272-1139)
COIL: 241 turns
#18 wire
19" dia.
5 pi
L=58.2 mH
Q=20
Primary: 3 turns
#14
C1
C2
9
: see notes


3500 Hz Cave Radio Receiver
F. Reid 12-5-73 rev. 7-6-81
10k
27k
+9
3.3 pf
LM301
Si
10k
-9
C3
9
100k
126.000 kHz
74C192
(÷ 7)
Vdd: 16
gnd: 8
10
74C73
(÷ 4)
Vdd: 14
gnd: 7
25 k
Carrier Level
100
120/15
2N4424
11
100
4500 Hz
400 mv p-p
6/15
+9
9v
9v
-9
13
ANT.
500 turns #28
26.5" dia.
L= 915 mh
2
select to resonate
pf
Q multiplier
(op amp: LF386 or 741)
1
R3
R2
R1
Q
100
Si
limiter
3
6/15
1k
1k
3.9k
(2)
43
+9
6/15
430
R4
4
MC1596L
balanced modulator
10k
10k
50k
430 (2)
Carrier Null
5
43
-9
6/15
6.8k
6
.05
300k
BPF
7
300k
narrow
wide
.22
1k
1M
741
LPF
8
.1
A
300 mh
.006953
0.1353 (2)
2.7k
CRYSTAL EARPHONES
12
: see notes