

# The 'HeyPhone' to the Rescue

**T**HROUGHOUT the UK, a band of enthusiasts spends its weekends squirming around in

horrible, dark muddy holes in the ground. This, at least, is the public perception of the sport of caving or potholing. As someone who finds a fascination in that mysterious world below the ground, though, I'd be inclined to use rather different language. I'd be more likely to come out with clichés such as "caverns measureless to man"

and talk about a personal voyage of discovery. I would enthuse over the beauty of pure white straw stalactites and the awesome grandeur of thundering subterranean waterfalls. I might even tell tales of exploration and heroism, and bandy around names such as that of the Victorian cave explorer, Edouard Martel. But, despite my enthusiasm over this world of darkness, I would have to admit to the commonly-held view that potholing is dangerous, or at least potentially so, to those who are inexperienced, careless or plain unlucky.

And when accidents happen, members of the volunteer cave rescue teams are called out to help those who are lost, cut off by rising water, have fallen, or are the victims some other catastrophe.

## RESCUE COMMUNICATIONS

NOT ALL CAVING trips are as quick or as easy as a jaunt into a tourist cave. Some cave systems contain tens of kilometres of passages, progress is often barred by vertical pitches which have to be abseiled down, and even horizontal motion can be a mixture of crawling and squeezing rather than walking. It's not surprising, therefore, that it can often take rescuers many hours to reach a casualty, and even longer to return to the surface with the hapless caver strapped on a stretcher.

Traditionally, therefore, the

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After 15 years of yeoman service, the 'Molefone', caving's standard transceiver, was approaching the end of its useful life. This is the story of its replacement - the 'HeyPhone'.

rescue team could be out of contact with the surface controller for hours on end. And if additional equipment or personnel were required, the only option would be to send a 'runner' back to the surface. This delay could easily cost lives. Cave rescue made a giant leap forward, therefore, when the 'Molefone' was introduced in the early 80s. Developed by Bob Mackin of Lancaster University, a member of the Cave Rescue Organisation in Clapham, North Yorkshire,

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it revolutionised cave rescue. Operating at a low frequency of 87kHz in order to penetrate the rock and employing the principle of induction rather than radiation to avoid the need for huge antennas, the Molefone allowed underground rescue teams to talk directly to rescuers above ground. Operating in the inductive near field doesn't provide long range communication, as the signal strength decays with the cube of the distance.

However, it does penetrate limestone to a depth of a few hundred metres which is perfectly adequate for most British caves. There are undoubtedly people walking around today who owe their survival to the Molefone.

## NEEDED – A NEW CAVE RADIO

BUT TIME moves on and, a couple of years ago, the British Cave Rescue Council (BCRC) recognised that they had a problem.

Although the Molefone had done sterling service, fifteen years is a long time to expect electronic equipment to survive in what must be one of the most hostile of environments. Being dragged along cave floors, being subjected to the occasional dunking, being dropped and generally abused for this length of time had taken its toll on the Molefones and the BCRC's member teams were starting to report failures.

To make matters worse, repair was difficult, if not impossible, because the PCBs had been potted in epoxy resin to improve their immunity to physical shock and some of the components were obsolete. It looked as if the Molefone was coming to the end of its useful life.

## RADIO AMATEURS TO THE RESCUE

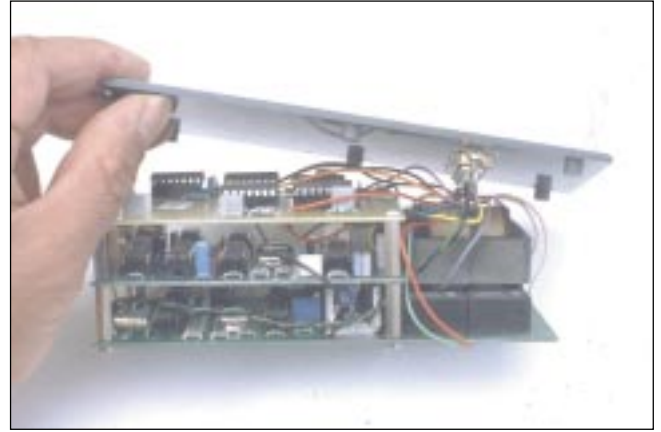
WITH A LOSS of communications capability looking ever



A HeyPhone in use on the surface above Carlswalk Caverns in Derbyshire.



The sealed bottom box contains the electronics, all connections being made via a single 25-way D-type connector to the top box, which contains damage-prone components.



The electronics is fitted on three circuit boards - the transmitter, the receiver and the control circuitry.

more likely, the BCRC used a field meeting, organised jointly with the Cave Radio & Electronics Group (CREG) of the British Cave Research Association (BCRA), to set up a project team to develop a new radio. A key player in that team was John Hey, G3TDZ, who had been developing cave radio equipment for a number of years and the decision was eventually made to base the new radio on one of John's designs. See the separate box, *Technical Details*, for more information on the circuit. But the design of a rescue radio involves much more than electronic engineering. It's a tribute to Bob Mackin that Molefones had proved so reliable over such a long period of time. Needless to say, therefore, an important element of the new radio was cave-proofing to ensure that they'd be equally reliable. Specifically, rescue radios must be protected against mechanical shock and wet conditions, and they must also be immune from misuse by rescue team members, many of whom are not communications specialists.

The mechanical design was undertaken by Brian Jopling, "Jopo", a member of the South Wales Cave Rescue Organisation and the BCRC's Equipment Officer. The novel design incorporates a two-part box. The main transceiver box contains the majority of the electronics, basically three PCBs - a transmitter board, a receiver board and a control board. The box is sealed against the ingress of water and all the connections to panel components -

switches, indicators and connectors - terminate in a 25-way D-type plug. The D-type mates with a connector in a 'top box' containing all the panel-mounted components and which attaches to the transceiver box.

This approach allows the moisture-sensitive electronics to be housed in a box which is almost devoid of holes. Furthermore, it allows the top box to be removed so that the damage-prone switches and connectors can be replaced without interfering with the main transceiver. This, in turn, means that basic maintenance can be carried out by the rescue teams' own personnel, who need only minimal expertise in electronic construction. For additional protection, it is recommended that the cave radio, together with the battery, microphone and antennas are carried in a tough, yellow, waterproof carrying case manufactured by Peli Products and called a 'Pelicase'.

## A MAMMOTH TASK

DESIGNING A RADIO is one thing, turning that design into working units is another. This is especially true when we bear in mind that the UK's rescue teams wanted a grand total of 66 transceivers, yet commercial manufacture would have priced them beyond the reach of some teams, all of which operate as charities.

Fortunately for the BCRC, though, the completion of the design coincided with John Hey's retirement. With the time on his hands to contemplate such an endeavour, John volunteered to undertake the electronic construction himself. And, at the time

of writing, that mammoth task - which involved populating almost 200 PCBs with around £7000 worth of components - is just about complete. But it wasn't just the populating of the circuit boards - that special two-part box wasn't an off-the-shelf component and the tooling costs would have made commercial manufacture too expensive. So, as John was poring over a hot soldering iron, Jopo set to work with a band saw, table saw, vertical router, bench drill, lathe, heat gun and many square metres of heavy-gauge PVC sheeting. His task was to make the 66 enclosures and - as he received the electronics from John - to put the boards in the boxes and carry out the final touches to the construction.

## THE BIG DAY

SUNDAY 1 April was a fine spring day at the Derbyshire Constabulary HQ in Ripley. This was the day of the BCRC's AGM, and it was also the day that representatives of many of the rescue teams would take delivery of their new cave radios. There were also surprises in store for John Hey, who was representing CREG at the meeting. For a start, it transpired that, as an acknowledgement of John's work in both designing and building the radios, the BCRC had decided to call their new radio the 'HeyPhone'. And then, as the meeting drew to a close, to underline further the BCRC's appreciation of John's efforts, BCRC Chairman Bill Whitehouse presented him with an inscribed glass plaque.

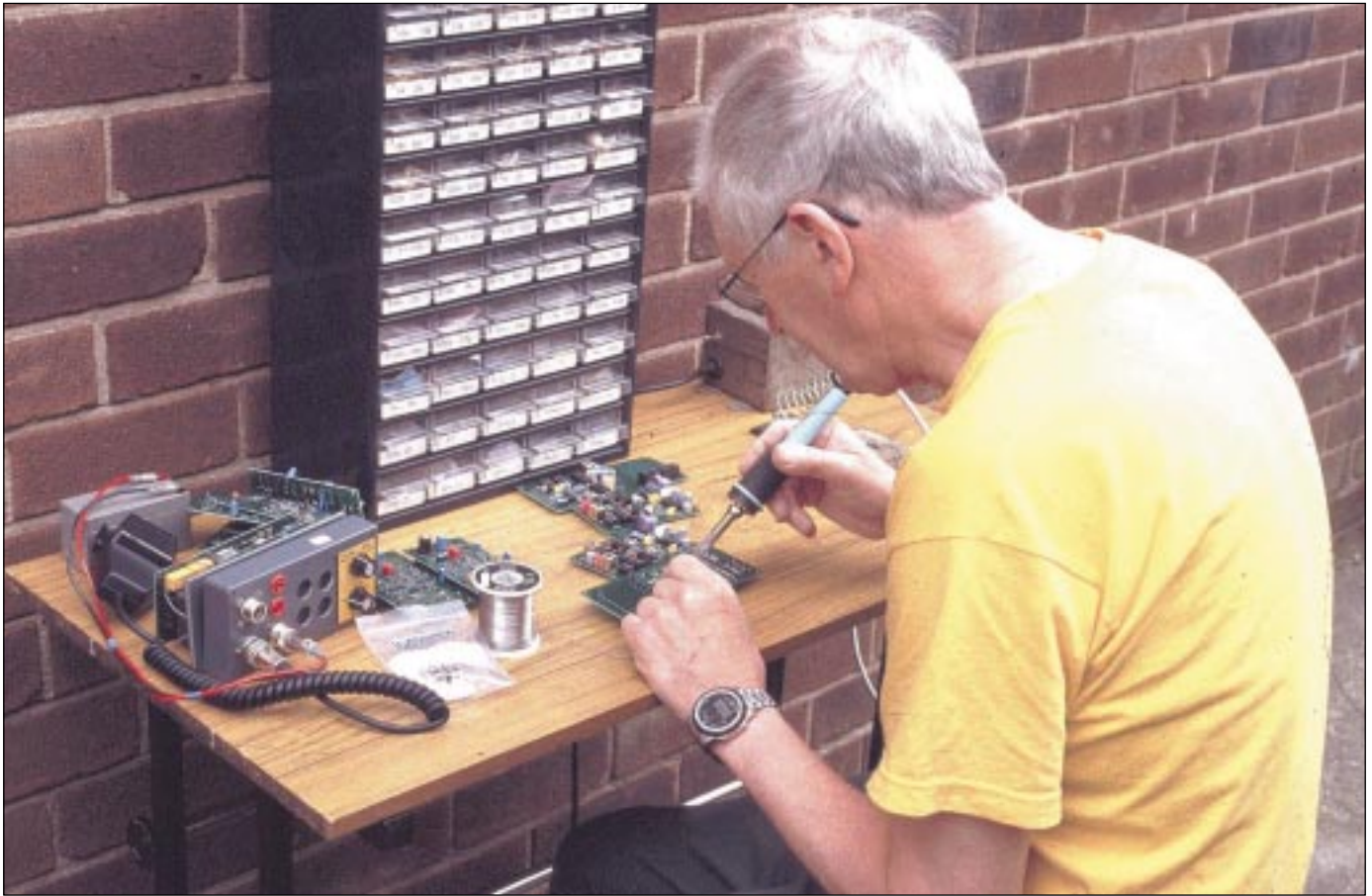
## TECHNICAL DETAILS

Because this is a combined technical *and* news feature, a few words about the circuit are appropriate. The electronic design is similar to the one described previously by John Hey, G3TDZ, in *RadCom* [1], with a few additional features requested by the rescue teams. To cut a long story short, this is an SSB transceiver operating at 87kHz for compatibility with the Molefone. SSB modulation and demodulation rely on an active phasing network, and the receiver is a direct-conversion design. The transmitter power output is in the region of 10W.

The Molefone used a multi-turn loop both for transmitting and receiving. The pair of loops can be thought of as analogous to a transformer, albeit one with a huge separation between the primary and secondary windings. This, of course, is quite different from the operation of a

conventional (ie non-inductive) radio system.

Although the new rescue radio will operate with loops, the primary method of operation uses earth electrodes instead, a technique which provides a much greater range and less directionality. This is similar to the baseband earth-current systems which were used during WW1 and, subsequently, by non-licensed amateur experimenters. However, it would be wrong to assume that the mode of operation is purely conduction; the actual mechanism appears to be a combination of conduction, the near induction and electrostatic fields, and perhaps even some radiation. Whatever the exact mechanism, though, results have been impressive. In early tests at Peak Cavern in Derbyshire a range of 800 metres was achieved.



John Hey, G3TDZ, working on a HeyPhone in his workshop. John has built 66 units, involving the population of almost 200 PCBs with £7000-worth of components.



The well-being of a cave radio is seldom in the mind of a caver hanging on a rope, so it needs to be robust. Chris Trayner, G4OKW, demonstrates.

### THE TRUE SPRIT OF AMATEUR RADIO

IN AN ERA of mobile phones and pervasive communication, the worth and fascination of amateur radio is lost on many members of the public. It's refreshing to

see, therefore, how radio amateurs within CREG, and John Hey in particular, have made a major contribution to public safety. Admittedly, the HeyPhone does not actually operate on an amateur band, but it was designed and built primarily by radio amateurs and this is something of which we can feel justifiably proud. This is amateur radio in the purest sense of the phrase. There is no equipment available off the shelf which would do this job and, as charitable organisations, the rescue teams couldn't contemplate having equipment professionally designed and manufactured. The only option, therefore, was an amateur project, and those involved responded magnificently to the challenge.

It would be nice to conclude by telling the story of someone whose life had been saved by rescuers using the HeyPhone. However, since caves and potholes tend to lie on footpaths, and these have been closed by the foot and mouth epidemic, few people have ventured underground this year so people have not needed rescuing. I'm certainly not looking forward to a time when people once again get into difficulties underground – after all, surely it's better for all concerned if people take care and accidents don't happen. However, as and when the countryside reopens, underground accidents *will* hap-

pen – there's nothing surer. And, when that 999 call comes in, we have every confidence that technology will be at hand to make the task of the rescue teams just that little bit easier.

### INTRODUCING CREG

SO, THE UK's rescue teams have a new radio which, we hope, will provide reliable service for many years to come. This doesn't mean that there's nothing left to be done, though. Ideas currently being discussed include wind-up power supplies for use in long rescues, low data rates for use when speech communication is difficult, and methods of overcoming other effects which make communication difficult in some caves.

Want to play a part in this exciting and unusual sphere of research? If so, why don't you make contact with Rob Gill, G8DSU, who is CREG's first point of contact? You can write to him at 61 Deep Cross Gardens, Twickenham, Middlesex TW1 4QZ or e-mail him at [creg@bcra.org.uk](mailto:creg@bcra.org.uk) You might also like to look at the CREG website at [www.bcra.org.uk/creg/](http://www.bcra.org.uk/creg/)

### REFERENCE

[1] 'Cave Radio - the Story so Far', *RadCom*, 76, No 7, July 2000, pp15-18. ♦