euro tek

edited and translated by Erwin David

*There are many aspects to LF reception. **Walter Geeraert, PE1ABR**, who listens not only for amateurs but also for LF DX beacons, gets good results with a big **aperiodic co-ax loop antenna**, augmented for 136kHz by a **preselector filter**. Condensed from* Electron *(NL) 2/99.*

AFTER YEARS of experimenting with active antennas [1] I wanted to have something to compare these with. In the first instance I wanted to listen to LF beacons, which required a range of 200 - 600kHz. A multi-turn tuned loop seemed the best option, but because of its self-capacity the desired frequency range cannot be achieved with a reasonable-size tuning capacitor. Switching turns did not work well, because of coupling between the sections and even greater parasitic capacities. A bank of capacitors with steps of 1-2-4...128 with 8 switches providing 256 steps up to many nanofarads worked well, but was not suitable for installing outdoors.

A SHIELDED LOOP

READING ABOUT a 2m diameter loop wound from 100m of coax (total turns area of about 200 square metres) I thought it worth a try. Tuning it over a wide range was out of the question because of the cable capacity, so it would have to remain untuned. I tried the principle with a single turn of 1 square metre, but the signal output was next to nothing. How about a very large single turn?

Between a pipe on the chimney with its top at 8m and a 5m pole at the bottom of the garden 30m away, I could hang a coax [2] loop of approx. 6m average height by 25m long, almost 150 square metres (see **Fig 1**).

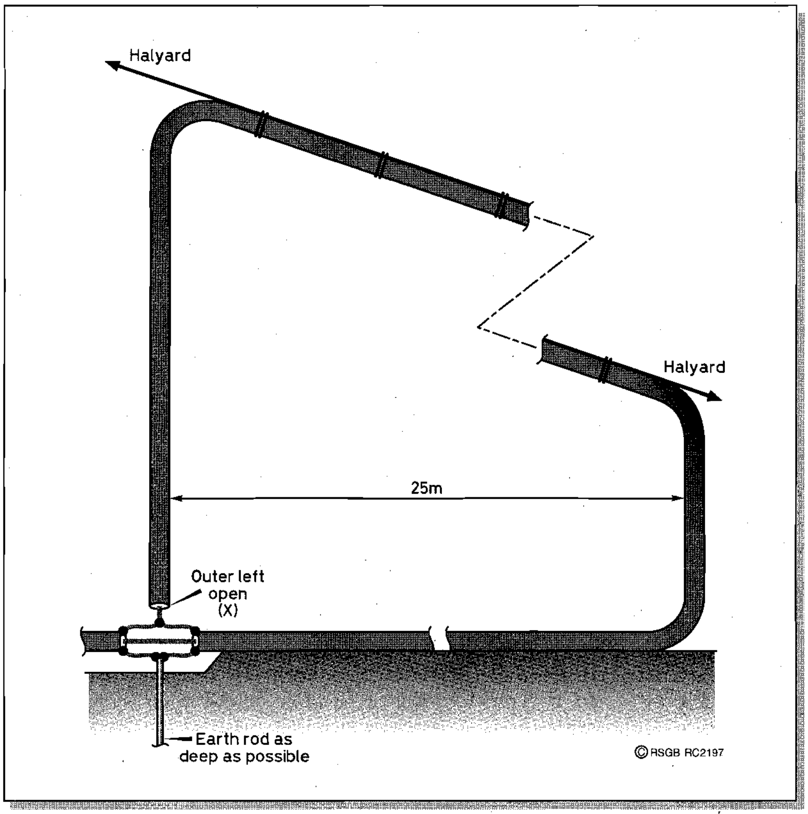

Fig 1: Schematic diagram of PE1ABR's untuned shielded VLF-MF receiving loop.

The feeder and both ends of the loop are brought into a weatherproof box separately, permitting either loop end to be connected to the feeder, with the core of the other end earthed and its outer left open. At first the lower run was just above ground, but later in a plastic tube just below the surface. It made no difference to the signal strength or noise.

Low frequencies penetrate deep into the earth, hence a long ground rod helps to reduce noise. Mine is a copper tube sunk 5m into the earth by squeezing the lower end until it is almost closed, then connecting the top end to the garden hose and drilling down with water power. Luckily, there are no rocks in the soil here.

The LF signal output from the coax loop is on a par with an odd piece of wire only 5 or 10m long, ie much lower than from the old active antenna. The weaker stations, S3 or S4 on the active antenna, are S0 on the loop, but noise and QRN were down even more! Shorting the inner and outer of the coax at point X in Fig 1 virtually killed reception; even the strong broadcast stations were very weak; with RG58C/U coax, the shielding worked!

The conclusion: An amplifier is needed to add gain. [This will be the subject of next month's *Eurotek* - *G4LQI*]

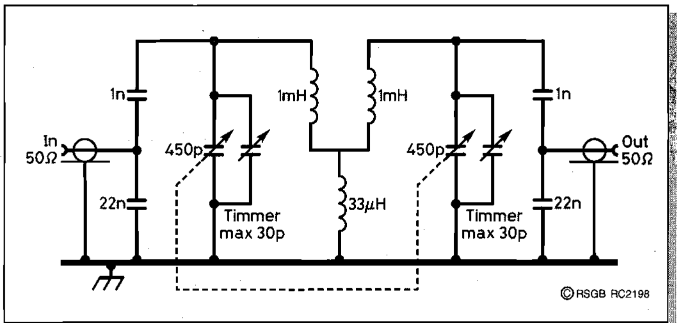

Fig 2: A preselector filter for the 136kHz band.

RESULTS

THE LOOP HAS greatly expanded my listening horizons. LF beacons were heard from Gander to Miami and east to the Persian Gulf. A list can be downloaded from http://web.inter.nl.net/hcc/Shortwave

1.8MHz signals which were inaudible on the active antenna or the 'odd wire' emerged from the noise. Maximum LF response is in the plane of the loop, but the nulls do not seem to be deep.

My receiver has inadequate preselection for weak stations in the presence of loud neighbours, so I use an antenna tuner. One, tuning 125-150kHz, is shown in **Fig 2**. The 1mH coils must be high-Q. Those I wound on orange ferrite rings were not; blue Neosid formers with dumb-bell shaped cores worked better [3].

With this preselector, 136kHz amateur stations received include G2AJV, G3LDO, G3XTZ and EI0CF.

NOTES

[1] Strictly speaking, PE1ABR's big untuned shielded loop plus amplifier is an active antenna.

[2] In selecting coax, consider the following:

- If only a narrow band such as 136kHz is of interest, a coax loop can be tuned, the coax capacity being a useful part of the capacity needed for resonance [*PA3HCD*].
- In an untuned loop, however, the cable capacity reduces the output, hence low-capacity is an advantage.
- Cheap TV antenna coax provides less noise-shielding than professional types.
- Coax will not support its own weight over a long stretch; it should be lashed to or wrapped around a tensioned 'messenger' wire. At the loop corners, sharp bends must be avoided.
- Larger-diameter coax is heavier and catches more wind, needing sturdier supports.
- Where subject to movement, coax with a stranded or copper-clad steel centre conductor is preferred [RG62A/U (47pF/m, copper-clad steel inner) may be a best-buy - *G4LQI*].

[3] Toko part 187LY-102J, Cirkit Stock no. 34-10201, with Q>90, seems suitable [*G4LQI*] ♦

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***Active receiving antennas** are small in respect to wavelength, use an amplifier to boost signal power while providing a match to the receiver input and assure the best possible QRN immunity. Described below is the amplifier used by **Walter Geeraert, PE1ABR**, with last month's big coax loop (*Electron *2/99) and a more generalised design by **A P Cheer** (Electronic Engineering 8/83), commented on by PA0SE (*Electron*, mid-1980s).*

A WIDE VARIETY of 'RF pick-up systems' can be called 'active antennas', as they combine the antenna proper with an amplifier. Included are the tuned loop with amplifier/Q-multiplier [1] by CN2AQ (SK); the untuned small loops with aperiodic amplifiers in G3FNZ's directional receiving system [2]; and, most widespread, the short whip with integral amplifier described here.

WHIP WITH INTEGRAL AMPLIFIER

A VERY SHORT antenna, ie a monopole less than λ/10 at the highest frequency to be received, has a virtually constant sensitivity below that frequency. That is ideal for 'all-band' receivers. The small size permits installation high and in the clear, ie outside the domestic QRN fog.

There are caveats, though. Electrically, a very short antenna is a very small signal source in series with a very high capacitive reactance. To get a reasonable output, it must work into a very high impedance load, eg a FET gate. Because there is no preselection, the amplifier must be ultra-linear, lest the intermodulation products of strong stations at any frequency bury the weak wanted signals. The bigger the antenna, the greater the linearity requirement.

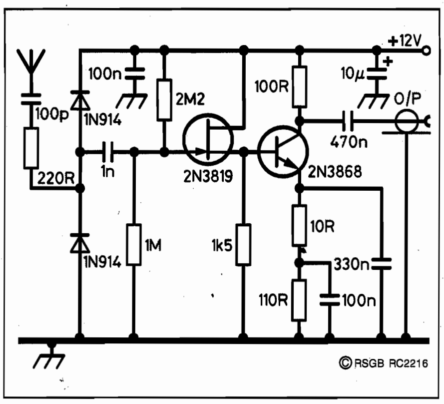

Fig 1: Broadband pre-amp for a 1m long monopole by AP Cheer (*Electronic Engineering* 8/83).

Locating the antenna as high as possible makes the amplifier susceptible to damage from static discharges during thunderstorms. Gas discharge cartridges [3] and diodes offer some protection, but accessibility to replace the FET is desirable.

To preserve the advantages of installation in a low-noise location, noise picked up by the outside of the coax from the antenna amplifier to the receiver must be prevented from reaching the amplifier input. [On HF, that is easy; ten turns of the coax on a ferrite ring just below the amplifier will be effective; but on 137kHz? A pair of E-cores [4] liberated from a 200W switching power supply of a computer wound full of the smallest available coax probably are the best one can do - *G4LQI*].

Fig 1 shows a typical diagram, to which the protective devices have been added. The voltage gain is given as 6dB, the 1dB compression point as 8dBm and the frequency range as LF through HF.

PA1ABR WIDE-BAND AMPLIFIER

WITH THE HIGHER composite signal of the big shielded loop, (BBC *Radio 4* on 198kHz produces S9+20dB without an amplifier) the linearity requirements for the amplifier are much greater. The circuit shown in **Fig 2** fills that bill. That amplifier existed, but its 50Ω input was not designed for this loop; PA1ABR therefore recommends the use of a tuner between the antenna and the amplifier [5]. He also has a choice of 50Ω attenuators used at the input or output of the amplifier; the latter does not overload, but his receiver does!

The static discharge problem and the danger of feeder pick-up are less here, because the outer conductor is earthed at the feed point of the antenna. A gas discharge cartridge is used at that point, though, and a relay removes the amplifier input from the feeder when not in use.

The amplifier is capable of 20dB gain; inverse feedback is used to reduce the voltage gain to where it is wanted for weak-signal reception. The amplifier is linear up to an output of >10V p-p.

The transformers, on orange Philips 27mm OD toroids [6], are effective from below 15kHz to above 10MHz. A bifilar choke in the lead from the wall-plug mains transformer suppresses any mains-borne noise.

REFERENCES

[1] *Eurotek, RadCom 4/97*

[2] *HF Antenna Collection* p.106 (RSGB)

[3] *HF Antenna Collection* p.228/9 (RSGB)

[4] Amidon EA-77-625 or similar

[5] The bandfilter in Fig 2 of *Eurotek* 4/99 does not match the antenna to 50Ω. A 1-100nF capacitor box in lieu of the 22nF input capacitor would do that, but with plenty of signal available this is superfluous.

[6] 27mm OD orange Philips cores are of 3E25 ferrite material. A_L = 6500. ♦

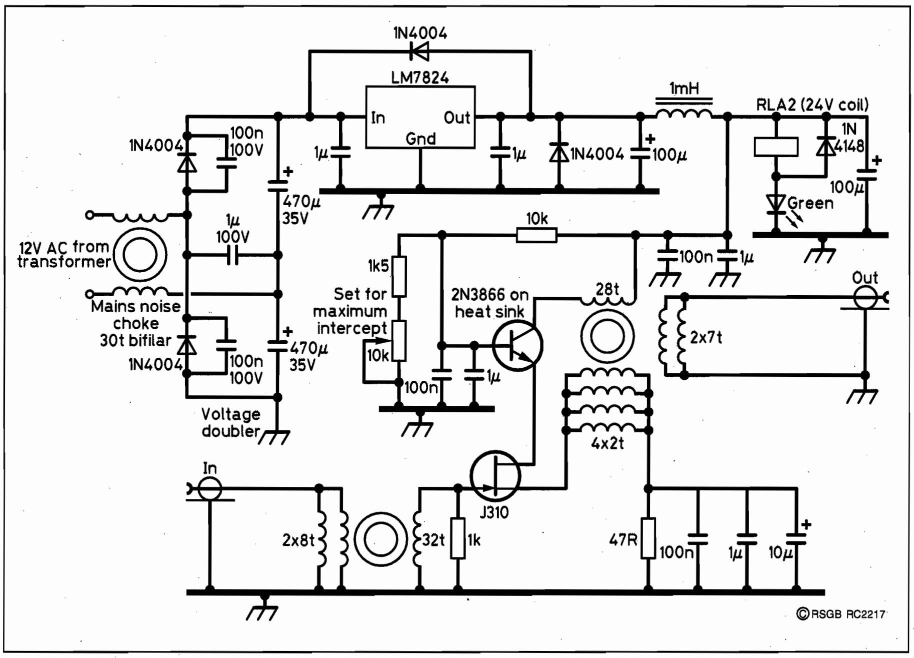

Fig 2: PE1ABR's broadband pre-amp, as used with his LF coax loop antenna (*Eurotek* 4/99).

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