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An 80- and 40-metre loaded dipole

This antenna uses loading coils in place of more conventional traps to obtain two-band operation. The idea of using loading coils in this way was described by W J Lattin, W4JRW, over 40 years ago [1]. It offers the advantage of simplicity over trap construction, and also results in considerable shortening of the antenna, which now takes up less space than the popular G5RV with its 31.09m (102ft) top, and the standard 33.53m (110ft) trap dipole.

The coil used in the 40/80m dipole is made from standard 40mm (1.6in) diameter PVC pipe. It is 17.8cm (7in) long, with a winding length of 14cm (5.5 in). Holes are drilled at each end to secure the aerial wire.

The inductive reactance of a coil increases as the frequency applied to it increases.

In the 40/80m loaded dipole (**Fig 1**), the coils are sufficiently large that they show a high impedance on 40m, and provide inductive loading on 80m. Lattin found that values between 80μH to 120μH gave good results when used in this way, the larger values of inductance requiring less wire on the outer sections for 80m resonance.

However, Lattin acknowledged that no exact formulæ have been found to determine the relationship between coil size, wire lengths, and the two frequencies for dual-band resonance. Therefore, the published design may be regarded as a starting point for experimentation.

It should be appreciated that, when an antenna is inductively loaded, several things happen. The most noticeable is the reduction in bandwidth of the system. The greater the loading, the smaller the bandwidth.

The efficiency of the antenna also decreases. However, this decrease in efficiency is dependent on where in the aerial the loading coils are placed and, more importantly, on the construction of the loading coils. In a loaded wire aerial, the size and weight of the loading coils have to be important considerations, so to some extent there will always be some compromise between efficiency and what is practical.

As the loading is increased and the aerial becomes shorter, the feed-point impedance decreases. With a very heavily-loaded antenna, it may not be possible to feed it with 50ohm coax, and some extra matching circuitry may need to be employed.

The 40/80m loaded dipole uses a commercial Ferromagnetics current-mode balun at its feed-point [5]. The aerial is made from flexible grey plastic-covered 14-strand copper wire.

LOADING COIL PLACEMENT

Using loading coils to achieve two-band resonance does mean that one has no choice but to place the coils a quarter-wavelength out either side of the feed-point on the higher frequency.

The advantage is that, on 80m, the radiation resistance is kept at a higher level in this configuration than if the coils were placed close-in to the feed-point.

The disadvantage is that it results in a narrower operating bandwidth when the aerial is used on 80m.

A good match is obtained to a 50ohm feeder on both 40m and 80m, although the bandwidth on 80m is restricted to about 60kHz between the 2:1 SWR points. No such problem occurs on 40m, where an SWR of about 1.5:1 was achieved across most of the band.

CONSTRUCTION

In my version of the 40/80m antenna I constructed the 120µH coils by close-winding 104 turns of 1.25mm (18SWG) enamelled copper wire onto a 17.8cm (7in) length of white PVC pipe of 40mm (1.6in) diameter. The winding length was 14cm (5.5in). Note that the total length of wire needed to construct these coils is a little more than that available from a standard 250g reel of wire. I used a 1kg reel of wire [3].

An alternative, although this has not been tried, could be to divide the wire from a 250g reel into two equal lengths and use these to wind as many turns as possible onto the two formers, making sure that they have the same number of turns. With care, it should be possible to achieve about 92 close-wound turns which will yield around 106µH. The dimensions of the antenna will be affected, but those given for the 120µH version should make a good starting point for experimentation. As always, when experimenting with antennas, make them longer than expected and then trim down for resonance.

The PVC piping is obtainable from most DIY outlets in 1.8m (6ft) lengths.

The antenna wire was fixed to each end of the loading coil via holes drilled in the PVC pipe. The ends of the coil were anchored through small holes in the coil, and soldered to the aerial wire.

A short section of the PVC piping was checked out in a microwave oven to examine for any heating effect. None was found, so it was therefore assumed that the material was quite suitable for use in this application.

Care should be exercised in the use of some PVC piping which may be quite lossy if it is carbon-filled.

The whole coil assembly was given two coats of marine yacht varnish. The operation of the aerial was not effected during periods of heavy rain, so the weather proofing provided by the varnish appeared quite adequate.

The aerial handled 400W from a linear amplifier without any problems, although this was only done when the SWR was no greater than 1.5:1.

The photos show the coil construction and the aerial components, together with a commercial Ferromagnetics current-mode balun [5].

Losses are greater in a voltage-mode balun if used off resonance where reactive components are present. A current-mode balun can easily be constructed by winding 5 to 8 turns of RG58 coax (5mm diameter) around a pair of stacked ferrite rings. For more information on baluns, see [2].

ADJUSTMENT

The 40m section needed to be 10.66m (35ft) per leg as opposed to 10.05m (33ft) for resonance. This was the same length as found by W4JRW.

If an aerial has end capacity-loading (as would be the case for a top-loaded vertical with a large capacity hat of wires fanning out from its top), its length can be reduced due to the end capacity. However, in the case of the 40m section in the 40/80m loaded dipole, inductive loading is seen at the end, and hence the opposite occurs with a resulting increase required for resonance at 7MHz. This effect should not be confused with inductive loading in series with an aerial rather than at its end. In the former case, the aerial will be electrically lengthened, and hence a shorter length of wire will be required for resonance.

The trimming of the end sections is very critical. I found that 1.27m (4ft 2in) gave resonance on 3774kHz with a resulting 1:1 SWR, the 2:1 SWR points occurring at 3805kHz and 3742kHz. The aerial should, of course, be trimmed for one's favourite part of the band.

The use of the auto ATU in my transceiver allowed for some limited excursion outside of the 2:1 SWR points on 80m. However, it should be appreciated that this in no way reduces mismatched line loss on the coaxial feeder.

As the coils also offer a high impedance on 15m, the inner section can be used as a 'near' 3lambda/2 dipole on that band. The actual resonance in this mode was found to be 20.2MHz but, using the auto ATU, the transceiver was able

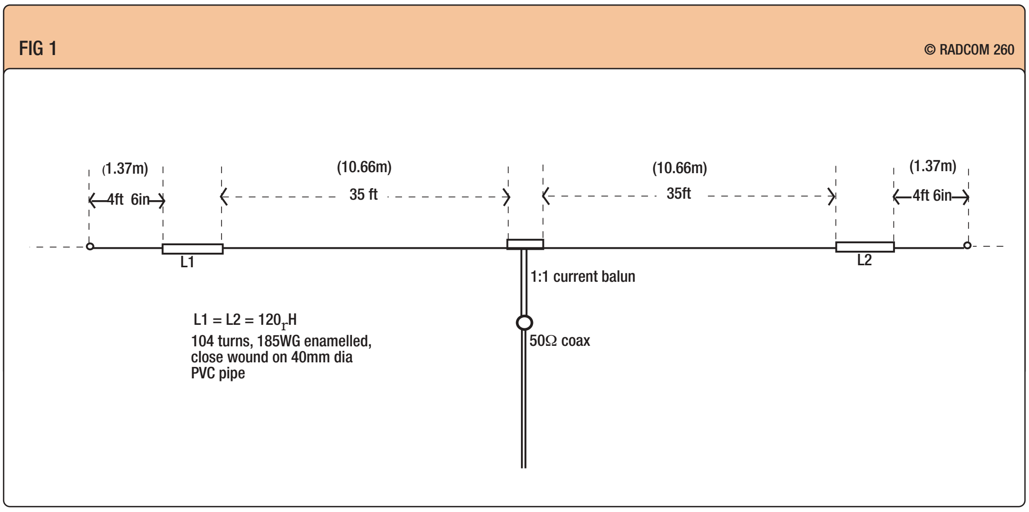

Fig 1
Dimensions of the 40 / 80m loaded dipole.

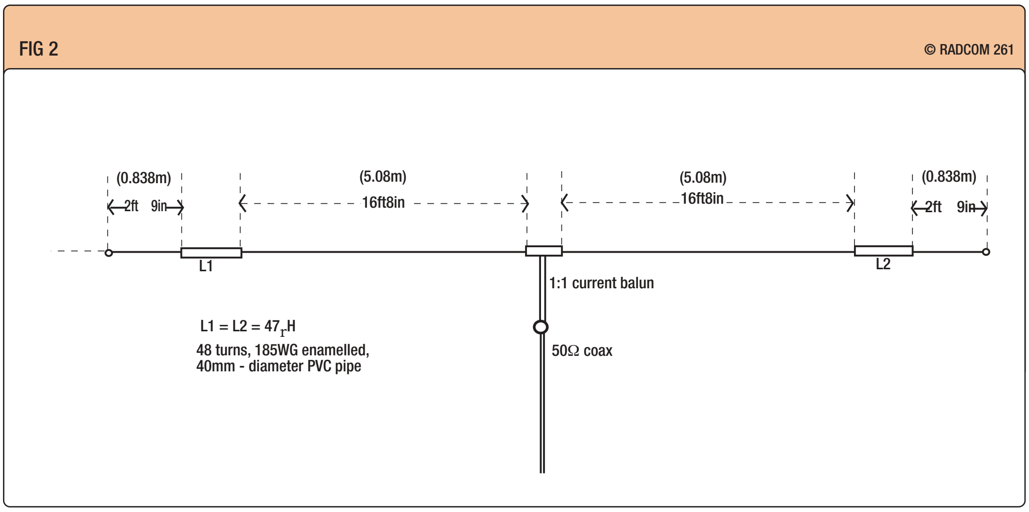

Fig 2
The 20 / 40m version.

to deliver full power across all of the 15m band.

160m OPERATION

The aerial may be used on 160m instead of 80m by extending the wires on the outside of the loading coils from around 1.22m (4ft) to 7.62m (25ft). This gave a 1:1 SWR on 1840kHz. The bandwidth between the 2:1 SWR points is in the region of 35kHz on 160m. The aerial will now function on 40 and 160m.

A 20/40m LOADED DIPOLE

A very successful 20/40m version was constructed and tested using the same principles as used for 40 and 80m (**Fig 2**). This had an overall length of 11.89m (39ft) and used coils of 47μH.

The coils were again made of 1.25mm (18SWG) enamelled copper wire, close-wound with 48 turns on standard 40mm (1.6in) diameter PVC pipe. Coil formers of 10cm (4in) length were used. The aerial had 5.08m (16ft 8 in) inner sections with 0.83m (2ft 9in) outer ends.

The SWR on 20m was less than 1.5:1 across most of the band, and the aerial showed a 1:1 SWR on 7072kHz with a 2:1 SWR bandwidth of 96kHz.

Typical dipole performance resulted on 20m, with good all-round reports on 7MHz.

EXTENDED OPERATION USING OPEN-WIRE FEED

If the standard 40/80m design is fed with open-wire line (or 450ohm ladder-line) coupled into the transceiver via a balanced ATU, the aerial could be operated efficiently on both 17m and 20m.

The inner section will operate as two half-waves in phase on 20m, and as a double extended Zepp on 17m with theoretical broadside gain figures of 1.6dBd and 3dBd, respectively [4].

On 21MHz and above, a multi-lobe pattern will result.

CONCLUSION

Using loading coils in place of traps, to get two-band operation, has the advantages of ease of construction and considerable reduction in antenna length. However, the main disadvantage is reduced bandwidth on the lower band.

The 40/80m design also offers useful operation on 15m. With the addition of a strapped 20m dipole at the feed-point, a reasonably compact four-band coaxial-fed antenna of just 24.08m (79ft) could be constructed.

Alternatively, the aerial could be fed with open-wire line to produce an inductively-loaded doublet.

The same principles outlined above could also be applied to multi-banding vertical or inverted-L systems.

Although the original intention of this article was to describe a compact and reasonably-efficient aerial for 40m and 80m, I have mentioned some other possible design variations that may encourage others to experiment further and develop a system suitable to their particular needs.

REFERENCES

[1] ‘Multiband Antenna Using Loading Coils’, W J Lattin, W4JRW, *QST* April 1961

[2] *Backyard Antennas*, Peter Dodd, G3LDO, available from the RSGB Shop

[3] Available from Scientific Wire Company, 18 Raven Rd, South Woodford, London E18 1HW. Tel: 020 8505 0002, website www.wires.co.uk

[4] *ARRL Antenna Handbook* 19th ed, available from the RSGB Shop

[5] Ferromagnetics, PO Box 577, Mold, Flintshire CH7 1AH. Website www.ferromagnetics.co.uk

DEDICATION

This article is dedicated to my long-time friend and neighbour, Ron Ford, G3NKO / C56RF, who was killed in the Gambia, West Africa, in September 2002 (see *RadCom*, Dec 2002, p10). ♦