« Eggbeater » Antenna VHF/UHF ~ Part 1

Appendix A

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Feeding the « Eggbeater » Antenna

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Balanced system

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Added in September 2009

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ON6WG / F5VIF

Appendix A

Feeding the antenna :

In this section, it is assumed that the impedance of a full-wave loop is 100 ohms or so. The feeding system proposed further back uses a phasing line made of one piece of coaxial cable. The type of the coaxial cable used for this purpose is **RG62** and its impedance is 93 ohms. As the two loops are connected together the resultant impedance is 50 ohms. Accordingly a coaxial cable having an impedance of 50 ohms is connected to one of the two loops and is used for feeding the antenna. This configuration is mainly proposed because it is the easiest to implement. Although the results are quite acceptable, this configuration is not the proper way to connect the feed line to the antenna and therefore it has some disadvantages. This feeding system is represented below in Fig A.

Note about the schematics presented below :

For clarity, Fig A and Fig B, presented below show the loops separated, but in reality they are mounted at right angles to each other and one loop is mounted inside the other one.

« Eggbeater »antenna : phasing line and feeder : *« Version 1 »* (simple)

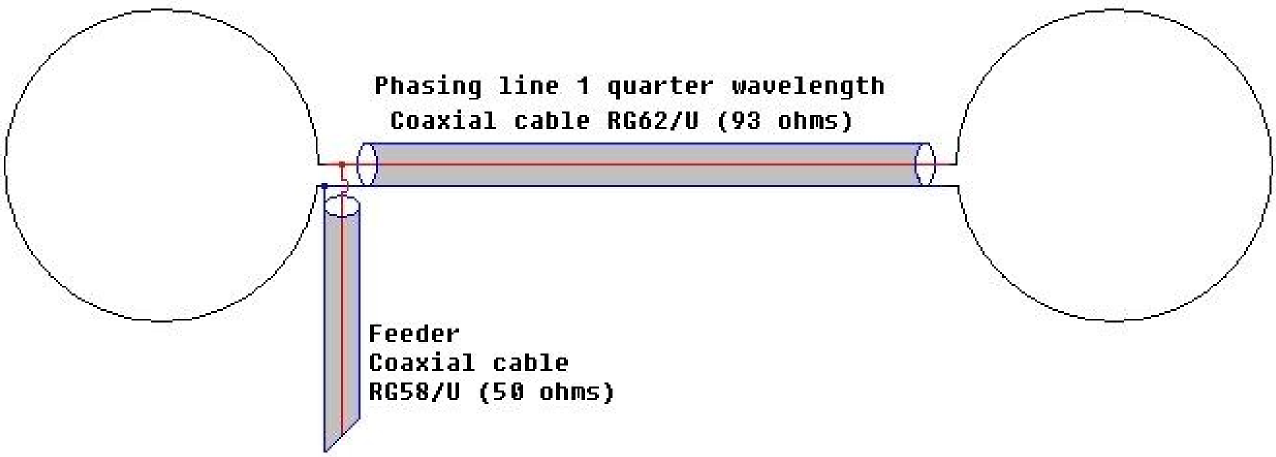

Fig A (Schematic not to scale)

To determine the length of the phasing line, refer to the paragraph « VHF or UHF « Eggbeater » Calculation » page 2.

Disadvantages and advantages of « Eggbeater » antenna *« Version 1 »* (unbalanced feeding system) :

In terms of electricity there is no advantage to use this version. A loop is a balanced antenna. Connecting an unbalanced line to a balanced antenna will present a discontinuity in the balance of the feed line resulting in radiation loss and distortion of the antenna pattern. In the case of the « Eggbeater » antenna it can result in an elliptical polarization rather than a circular polarization.
On the other hand what is then the advantage to use this system ?
The use of a coaxial cable as a phasing line between the two loops was introduced because it is the simplest way to achieve the antenna, and anyway to get a good result. This scheme takes also less space inside the sleeve assembly fitted under the antenna (it is useful in case we want to add a coaxial relay switch to reverse the polarization).

To avoid imbalance in the antenna system and the disadvantages described above, the antenna requires a feed line carrying equal and opposite currents. Only a parallel two conductor feed line will give this result. Here is the detailed schematic of such a system.

« Eggbeater »antenna : phasing line : « *Version 2* » (balanced system)

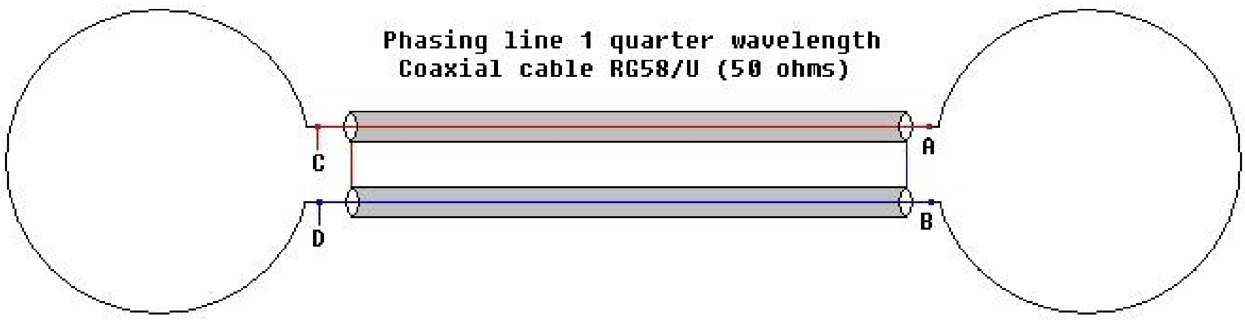

Fig B

The loops are connected to each other with a line made of two parallel pieces of coaxial cable RG-58. These two pieces of coaxial cable are one quarter wavelength. The braids are soldered together at both end. With this type of connection the impedance of the phasing line is 100 ohms. (Note : This parallel phasing line can be used to replace the coaxial phasing line in « **Version 1** »). As the loops are connected in parallel, the impedance at points « ***C*** » and « ***D*** » or « ***A*** » and « ***B*** » is 50 ohms.

To match an unbalanced source (coaxial cable from RX/TX) to a balanced load (antenna) we need to use the properties of a **coaxial 4:1 BALUN transformer**. Unfortunately, in this case, there is a side effect. This BALUN will give an impedance step up ratio of 4:1. As the impedance of the feeder is 50 ohms it will provide a match for a 200 ohms terminating impedance.

Consequently, a **Q-section balanced line** (quarter-wave transformer) must be added to convert the high output impedance of the BALUN (200 ohms) into the low impedance of the antenna (50 ohms).

The detailed schematic of such a system is presented below on **Fig C**.

Q-section calculation :

1) Impedance :
   After calculation, the impedance of the Q-section is also 100 ohms.
   (Q-section formula : $Zo= \sqrt{(Z_L \times Z_A)} \rightarrow \sqrt{(200x50)} \rightarrow \sqrt{10000} = 100\ \Omega$)
   Therefore the Q-section is similar to the phasing line and can also be constructed with 50 ohm coaxial cable « RG-58 ».
2) Length (VHF Eggbeater) :
   [(300 / F(in MHz) : 4] x coax. velocity factor → [(300 / 145) : 4] x 0.66 => 34.15 cm
   [(491,8 / F(in MHz) : 2] x coax. velocity factor → [(491.8 / 145) : 2] x 0.66 => 13.44 inches
   N.B : velocity factor for coaxial cable RG-58 : 0.66 is a usual value.
3) Length (UHF Eggbeater) :
   [(300 / F(in MHz) : 4] x coax. velocity factor → [(300 / 435) : 4] x 0.66 => 11.38 cm
   [(491,8 / F(in MHz) : 2] x coax. velocity factor → [(491.8 / 435) : 2] x 0.66 => 4.48 inches

Construction of the Q-section :

The Q-section can be built exactly the same way as the balanced phasing line.

« Eggbeater » antenna : feeding harness including feeder, coaxial 4:1 BALUN and Q-section :
***« Version 2 »* (balanced system)**

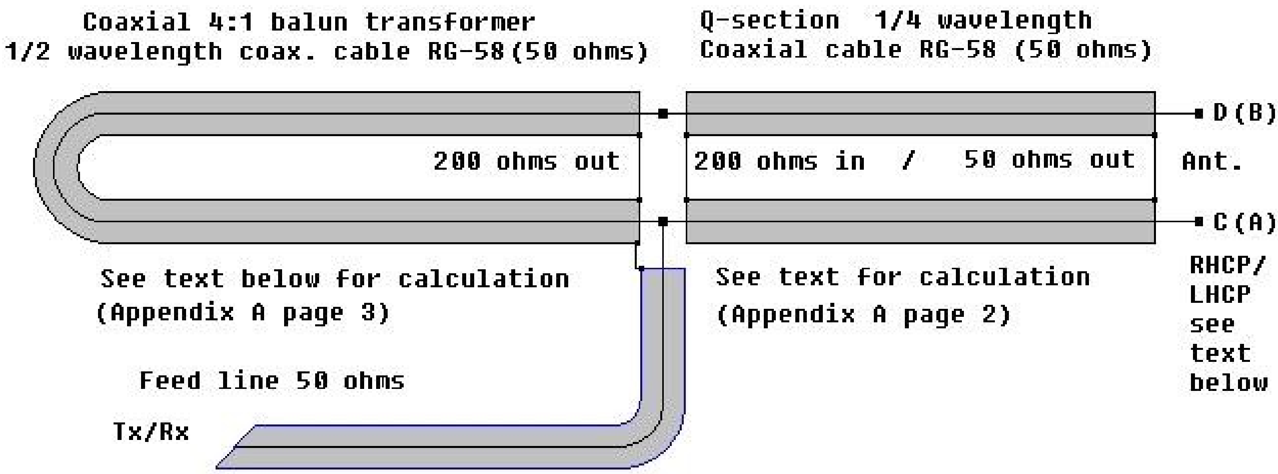

Fig C (Schematic not to scale)

Coaxial 4:1 BALUN transformer calculation :

1) Impedance : input : 50 ohms / output : 200 ohms
2) Length of the U-shaped section of coaxial line (RG-58) (VHF Eggbeater) :
   ½ λ x (velocity factor) → [(300 / F(in MHz) : 2] x coax. velocity factor
   → [(300 / 145) : 2] x 0,66 = 0,682 m → 68,2 cm
   ½ λ x (velocity factor) → (491.8 / F(in MHz) x coax. velocity factor
   → (491.8 / 145) x 0.66 = 2.24 feet → 26.88 inches
3) Length of the U-shaped section of coaxial line (RG-58) (UHF Eggbeater) :
   ½ λ x (velocity factor) → [(300 / F(in MHz) : 2] x coax. velocity factor
   → [(300 / 435) : 2] x 0,66 = 0,2276 m → 22,76 cm
   ½ λ x (velocity factor) → (491.8 / F(in MHz) x coax. velocity factor
   → (491.8 / 435) x 0.66 = 0.746 feet → 8.95 inches

The « feeding harness » represented in Fig C can be connected to either loop. In the example shown here it is connected to the antenna at points « ***C*** » and « ***D*** » to obtain right hand circular polarization (RHCP) (see Fig D). Left hand circular polarization (LHCP) can be obtained by connecting the harness at points « ***A*** » and « ***B*** » (see Fig D). To have the desired result follow exactly the directions given in the Fig C and Fig D. The braid of the U-shaped coaxial BALUN is connected to the braid of the feed line and therefore to the ground.
The phasing line and the Q-section do not need to be grounded.
If necessary the length of line constituting the BALUN (U-shaped section) can be rolled up.

Connections : physical design

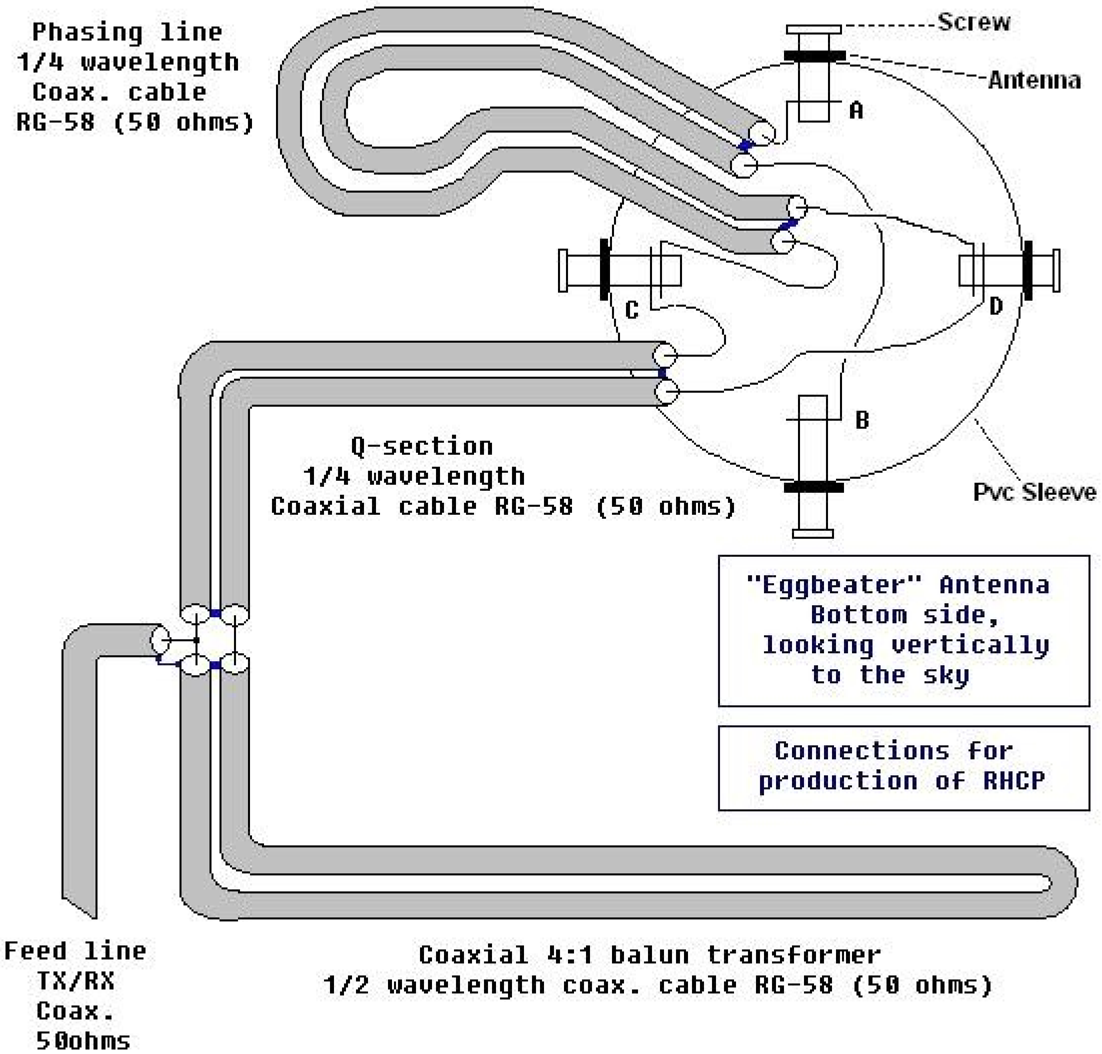

Fig D (schematic not to scale)

Conclusion :

Installing a balanced feeding system (feeder, phasing line and BALUN) does not necessarily mean that it is going to result in any detectable difference. But at least it will give a predictable pattern and the drawbacks of the unbalanced system will also be avoided.

Polarization interchange by coaxial relay :

A coaxial relay of the type TOHTSU CX-800 or two coaxial relays of the type CX-120 could be used to achieve a reversal of polarization in a system of parallel lines as presented above.

Fig E (Picture : Tohtsu)

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End of the Appendix A