RADCOM TECHNICAL FEATURE

Experimental Magnetic Loop Antenna

by C R Reynolds, GW3JPT

I HAVE CONSTRUCTED many magnetic loop antennas, all of which were made from 22mm copper tubing or strip aluminium. These loops were quite small, being only three metres in diameter and were designed originally for the higher frequency bands. I wanted to operate on the lower frequency bands and I found that it was possible to tune a 3m loop to top band using a very large 1000pf capacitor.

This caused two problems. At 160 metres the efficiency is rather low and on 40 metres tuning is rather tricky. The reason for this tuning problem is because it only takes a few picofarads to tune the whole of the 40m band. This represents a very small percentage of 1000pF, requiring only a fraction of capacitor rotation to cover the band.

I decided to try a different design of a practical loop antenna for the 160, 80 and 40 metre bands. This uses a much larger loop of a size shown in **Fig 1**. If this were to be made from copper tube it would be very heavy so I used a 64ft length of plastic covered wire. This antenna requires a tuning capacitor of 250-300pF.

The radiation pattern of a loop antenna has two null points. If the loop is made rotatable these nulls are useful for minimising some types of electrical interference or interfering signals.

The antenna could be made as a triangle. This would allow the antenna to be constructed without the top element support but would require a larger spreader at the bottom. Alternatively, the bottom spreader could be dispensed with and the shape maintained using insulators and guy wires but it would not be easy to rotate such a structure.

Various experimental loops with the LF version on the right.

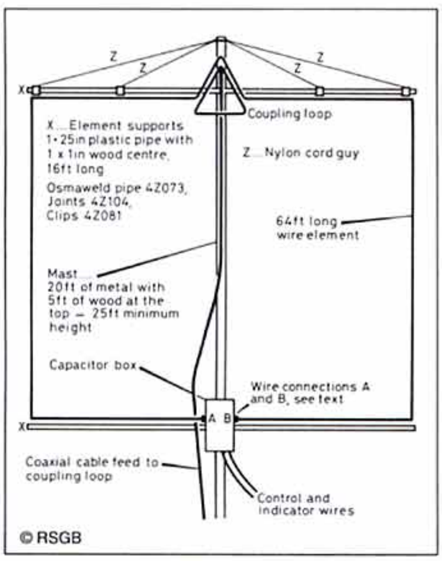


Fig 1: Overall view of the LF band magnetic loop.

The Faraday coupling loop is shown in **Fig 2**. It is close coupled for about 30in each side of the centre of the triangle section of the element.

This wire loop will also work on 40m. This is done by using a relay or a switch to disconnect the capacitor at points A and B, see Fig 1. The loop is then tuned by the stray capacitance of the switch or the relay. Because this stray capacity cannot be varied, the antenna element length is adjusted for correct matching using an SWR meter.

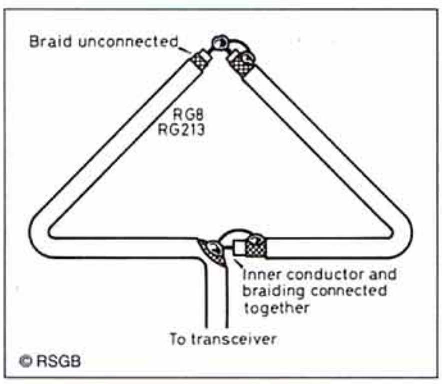


Fig 2: The Faraday coupling loop.

The antenna and mast can be fitted to a good ground post. It does not need any guys and can be raised or lowered easily. For portable use it can be erected in a few minutes using three or four guy wires.

CAPACITOR DRIVE MOTOR

THERE IS A reasonable range of motors available suitable for rotating the loop capacitor. The cheapest, and one of the best I could find was a barbecue spit motor. Although this is already geared down it does require extra reduction using a 6:1 or 10:1 epicyclic drive for more precise tuning.

The motor will rotate slowly if energised by a 1.5V battery. With 3V applied the motor will run much faster. By switching from 1.5 to 3 volts a fast or slow tuning speed can be selected. This switching is shown in **Fig 3**. The positive lead of the 3 volt battery is connected to H and the positive lead of the 1.5V battery is connected to L. The negative leads of both batteries are connected to D.

The direction of rotation is achieved using a two-pole, three-way switch. When the switch is set to the centre position the motor is disconnected from the battery (OFF position). The battery polarity to the motor is selected by the two other positions of the switch and should be labelled DOWN or UP.

The drive mechanism must be electrically

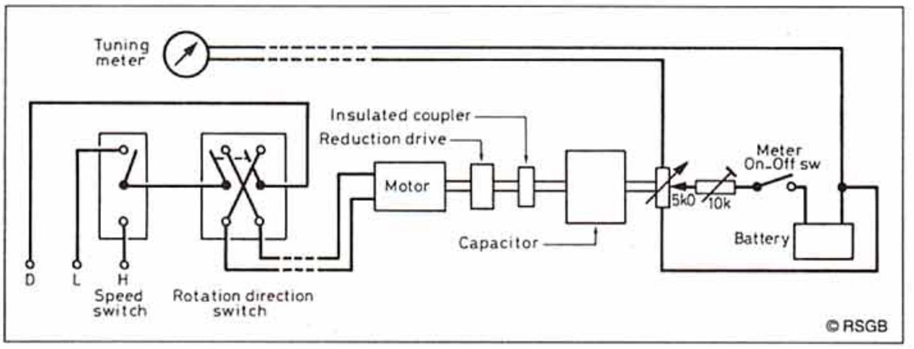
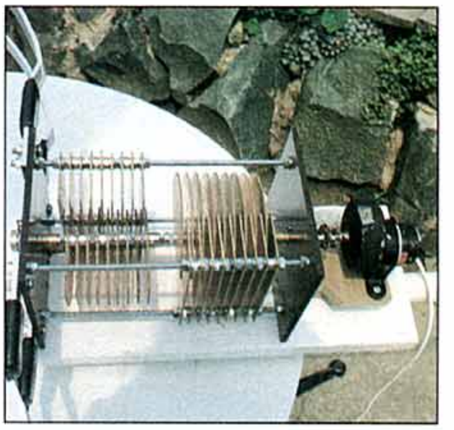


Fig 3: Control and inductor systems for the magnetic loop antenna.



Construction of the home made capacitor.

isolated from the high RF voltages present at the capacitor. An insulated coupler can be made from plastic petrol pipe. This pipe size should be chosen so that it is a push fit on to the drive mechanism and capacitor shafts. The pipe can then be fixed to the shafts by wrapping single strand copper wire around the ends of the pipe and tightening with a pair of pliers.

All the capacitors I have made have the spindle extending both sides of the capacitor. One spindle is used to couple the capacitor to the drive mechanism. The other is used to connect the capacitor to a position indicator (Fig 3). This indicator circuitry must be electrically isolated from the capacitor as described above.

The control unit is housed in a plastic box. The fast/slow and rotation direction switches are fixed to the front, together with the capacitor position meter.

CAPACITOR UNIT HOUSING

ONE OF THE main problems of constructing any electrical circuits associated with antennas is protecting them from wind and rain.

One option is to try and find some sort of suitable plastic housing and then organising the components to fit, but I prefer to make the tuning housing from exterior plywood. The bottom and sides of the box are fixed together using 1in square strips of timber. Glue and screws are used to make the joints waterproof. The top must, of course, be made so that it can be removed fairly easily. Paint or varnish the box as required.

CONSTRUCTION OF CAPACITORS

THE CAPACITORS FOR tuning loop antennas are very difficult to come by so I make my own. I have used various methods and materials to make capacitors, including aluminium and double-sided circuit board for the vanes. I use nuts and washers for the spacers and various types of insulation board for the end plates.

The capacitor illustrated on this page can be made as follows. The centre spindle and spacing rods are constructed from 6mm threaded plated steel rod.

Make the 3 x 3 inch end plates first, see **Fig 4**. These can be taped together back-to-back for marking and drilling. The same can be done with the vanes. Masking tape is used so the surface is not scratched around drill holes which are drilled to clear 6mm with the centre hole acting as a bearing.

The length of the 6mm spindle is dictated by the number of vanes required. For double-sided board I use washer/nut/washer spacers so that there is no need to bond the copper sides, resulting in a spacing of about .25ins.

The first capacitors I made used the conventional shape for the moving vanes, but this is very difficult to cut out and fragile to use. The shape illustrated in **Fig 4** can be cut out with all straight lines using a hacksaw, or cut with a jigsaw.

The fixed vane is a simple rectangle which can be modified to reduce the minimum capacity. (dotted line Fig 4c). For the size shown six pairs of vanes with 0.25in spacing work out to about 150pf. I have had units using both printed circuit board and aluminium vanes in use for over two years and they are both still in good working condition.

OPERATION

Tuning of the loop needs to be adjusted precisely for minimum SWR, which should coincide with maximum power out. This tuning is critical; a few kilohertz off tune and the SWR will rise dramatically. The best way of finding the correct position of the tuning capacitor is to listen for maximum noise, or signals, whilst tuning the loop. Then fine-tune using an SWR meter.

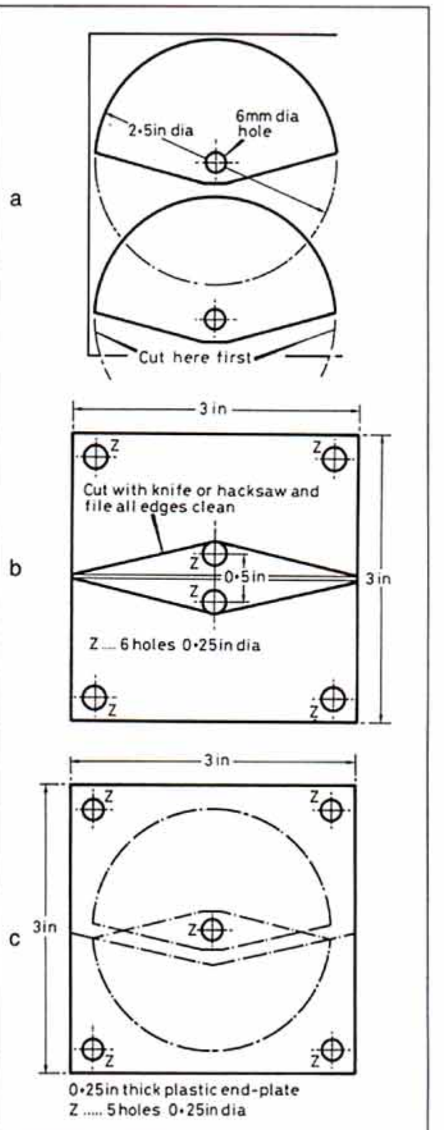
The performance of this antenna on 80M was at least as good as my G5RV. It tuned all of top band and gave quite good results as compared with local signals on the Club nets.

COMPONENT SUPPLIES

THE SWITCHES AND SLOW motion drive can be obtained from components suppliers such as Maplin. The threaded rod, nuts and washers can be obtained from any hardware supplier.

WARNING

HIGH RF VOLTAGES exist at the capacitor when the transmitter is on.



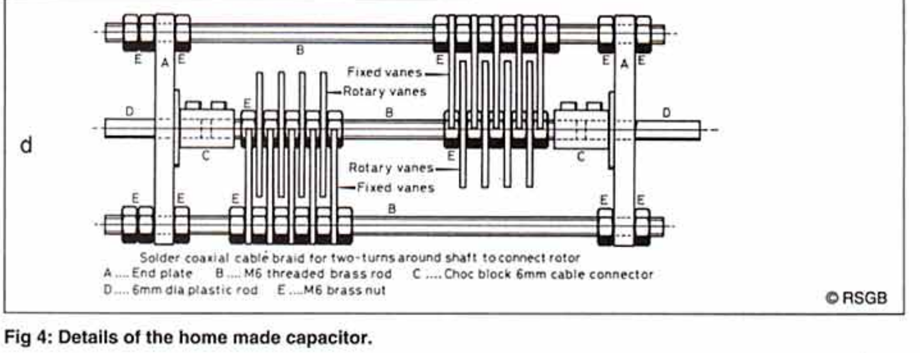


Fig 4: Details of the home made capacitor.