Antennas

Shorted turn inductance tuning and another look at loop antenna Faraday coupling loops

PHOTO 1: The experimental setup to measure the effects of a shorted turn, brass slug and ferrite rod on the inductance of a coil.

SHORTED TURN TUNING. Ted, G3IVH contacted me regarding a question I posed regarding how the tuning arrangement in Figure 4B of February Antennas (repeated here as **Figure 1B**) worked. This tuning method employs a shorted turn that can be positioned anywhere along the length of the coil. But how effective is it?

He constructed a coil 4½in (11.4cm) long and 1¾in (4.4cm) diameter on a ceramic former. The former had grooves for the winding, accepting 81 turns. It was thought to have been part of a roller coaster. The coil inductance measured 99.9μH. The shorted loop was moved along the coil in steps of ½in and the measured results are shown in **Table 1**.

I repeated the measurements using a coil 8.3cm long x 5.5cm diameter, which measured 135.7μH. The shorted turn comprised a loop of 14SWG wire with two layers of insulation to maintain a constant distance from the inductance wires as it was moved. The experimental setup is shown in **Photo 1**.

The coil former of my inductor was longer than the coil itself and I noticed that the shorted turn had some effect on the inductance when placed on the coil former around 3cm from the end of the coil (shown as –3cm in **Table 2**). As the shorted turn is moved closer to the inductance the μH value decreases but the greatest rate of change occurs when the shorted turn is moved over the first 3cm of the inductance. Note that there is very little inductance rate of change as the shorted turn is moved over the centre of the inductance. Table 2 shows the tuning range of the shorted turn method is over 30μH.

I tried adjusting the inductance by moving a brass slug in and out of the coil. The brass slug was made up of several lengths of brass rod fixed together with tape as shown in Photo 1, although it didn't fill up all the space within the diameter of the coil. The brass slug tuning method resulted in a tuning range of only 7μH. The effect of a ferrite rod of unknown pedigree, also shown in Photo 1, was also measured. This resulted in the much more dramatic tuning range of over 200μH.

For many years I have been experimenting with LF, first with 73kHz, then 136kHz and finally 501kHz. An e-mail LF reflector was created to exchange information and it is fortunate that within that group is a body of expertise that I occasionally draw on. I put the question of shorted turn tuning to the reflector and received the following comments:

Markus, DF6NM, found that the method worked very well. He goes on to say: "The nice thing is that you don't need the flexible connections for the rotating part (like a variometer) whereas the downsides may be less tuning range (and only 'up' in frequency because the loop decreases the inductance). There may also be a slight increase in losses. The wire loop can be replaced by a metal plate, but (at least for LF), a shorted multiturn coil made from RF litz wire would minimize induced losses".

DF6NM has also been experimenting at VLF (9kHz) and has tried rotating a ferrite plate, sandwiched between two copper sheets. In an orientation parallel to the magnetic field, the ferrite enhances inductance, whereas in the orthogonal position the eddy currents decrease it. The tuning arrangement finally ended up without the copper as sufficient tuning range was obtained with the ferrite alone. He notes: "The 90° turning range (compared to 180° for a traditional variometer) feels a bit unusual, but allows the use of a very simple mechanical arrangement comprising a string attached to one side of the plate".

John, W1TAG, tells me that it used to be common MW broadcast practice to use 'eddy current disks' comprising aluminium rings. In some cases, the ring was put inside the coil, with the ability to rotate it in and out of the plane of the turns. A simpler setup was to have it at one end, mounted on a threaded rod, allowing it to be moved along the axis of the coil. He goes on to say "I'm sure there were consequences for 'Q', but I don't recall any heating issues".

The coil in Figure 1B was suggested as a method of tuning a mobile antenna although I had never heard of anyone using it. So I was interested to receive the following from G4GVW. "Many years ago, when I did 160m mobile, I used an arrangement where the mobile antenna had a loading coil, which used a copper disc approximately 150% of the coil diameter.

TABLE 1: The effect of a shorted turn on a 99.9μH coil measured by G3IVH.

Position (cm)	Inductance (μH)
0	99.9
1.3	97.4
2.5	96.9
3.8	96.9
5.7	96.5
7.6	96.9
8.9	97.9
10.2	97.4
11.4	99.9

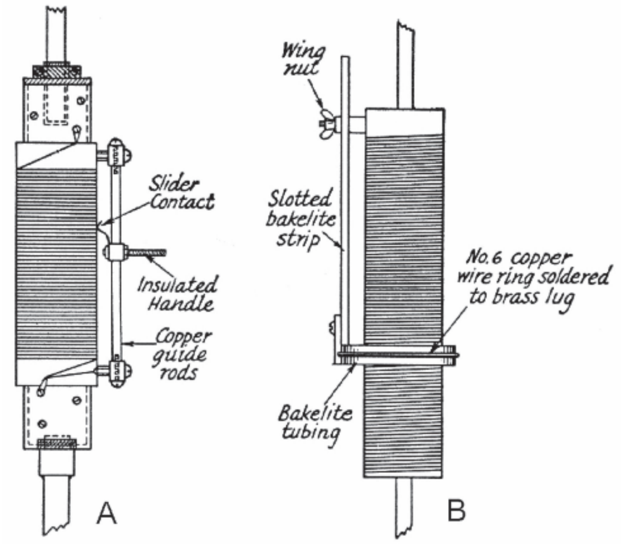

FIGURE 1: The shorted turn inductance tuning method (Figure 4B of February Antennas) repeated here as the subject for discussion in the text.

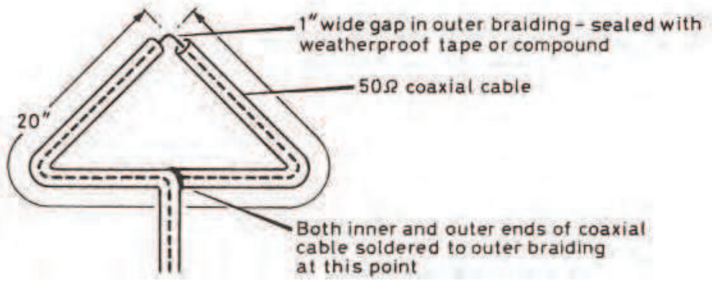

FIGURE 2: A transmitting loop antenna coupling loop from by G3KPV (*RadCom*, September 1983).

This was fixed to a centre boss that could be adjusted and locked along the whip with a screw at a point close to the coil. I used to puzzle over the difference between capacitive or 'shorted-turn' effects but in the end just accepted that it worked for whatever reasons. From memory I think the coil was about 5in diameter".

LOOPS LOSSES. Dave Penny, G3PEN e-mailed on the subject of small transmitting loop losses. He notes: "Regarding your recent article in *RadCom* on loop aerials (December 2010), I may be able to add something to the comments about the resistance of joints. I'm not sure where I read this, but I know that the skin resistance of solder is considerably higher than it is for pure copper and, at HF, the skin depth is very small. Consequently, if you make a joint in a copper pipe as is often done for water pipe usage, with a nice flow of solder beyond the actual copper join, the RF loss is increased – though by how much I haven't a clue because the RF has to flow through (over?) the solder surface.

"It is therefore considered important to clean off the surplus solder that is on the copper pipe, so that the only solder is that between the two pieces being joined, leaving polished copper right up to each side (edge) of the joining piece (if using plumber's sleeves) or to the single edge that shows if using a swaged joint (considered slightly better in fact, if made very tight). This gives an absolute minimum of solder surface across which the RF has to flow. Within the joint, I am not sure what is actually happening, as in theory all the RF current ought to be on the outside only – which perhaps makes the DC current tests for joint integrity somewhat dubious as regards a low loss at RF.

"I have been a little bit bothered by the various articles written over the past year or so in various publications, without this point being made, although it is only now that I have found time and energy to comment! Also, referring back to polishing the copper, again because skin resistance is so important, a very clean smooth surface for the entire loop, polished and then protected by a good-quality varnish, may be very worthwhile in the longer term."

The soldered joint problem could possibly be overcome using compression joints. These are a bit more expensive than soldered joint fittings. Furthermore they only seem to come in 90° angles and not 45°. This means that you could only make a square loop rather than a hexagonal using these items. An additional advantage of compression fittings is that a loop constructed using these can be dismantled for transportation or for moving through a hatch into a loft space. A square loop can be designed so that it can be fed at one corner with the capacitor at the other corner and orientated so that it fits into the apex of the roof inside a loft.

LOOP COUPLING. Alan Strong, G3WXI, noted my remarks regarding Faraday loop coupling in small transmitting loop antennas and says: "I read your comments with interest. I too was puzzled by the arrangement suggested by Robert, I1ARZ when I first read his February 1998 and subsequent articles. I wondered if the object may be to create a more balanced feed but in the absence of any definitive reference source I had to let the matter rest.

"A few days ago I dug out an unused AEA Isoloop still in its packaging, with a view to using it in my current experiments with WSPR, so the arrival on Friday of *RadCom* containing your piece was most timely. I had a problem with the Isoloop (which proved to be a faulty RF connector) and in the course of finding the fault I looked carefully at the coupling arrangement. That also does not appear to have any connection at the gap in the screen of the coax coupling loop. Furthermore I recently revisited a piece 'A Compact HF Antenna for Portable or Base Operation' by G3KPV (*RadCom*, September 1983) and that also does not show a connection in the gap". See **Figure 2**.

COMMUNICATION. I feel that I have to explain the changing e-mail addresses that have recently appeared in this column and apologise for any problems that you might have had trying to contact me. I was with UKONLINE for many years, in fact since the days of dial-up. In late November 2010 I received notification that the service had been bought out and the new owner was closing down the UKONLINE mail server. My e-mail address would cease to function. The new owner offered me generous terms to sign up with them and I was told that the transfer would be quick and painless. Because I wanted a simple and speedy solution to get the e-mail address into the Antennas column heading (bear in mind this column is written up to two months before it appears in print) I phoned straight away and asked to transfer. I put the promised new e-mail address in the January column. But by early January I hadn't heard anything from them so I started making enquiries. To cut a long story short, I changed service provider again and my e-mail address is now g3ldo@o2.co.uk. I haven't done anything about my web pages as yet. I was surprised to see that my website is still active but it is woefully out of date. Furthermore, I am now unable to update it so I am unsure what to do next. If you are interested just type G3LDO into Google and see if it is still active.

TABLE 2: The effect of a shorted turn on a 135.7μH coil measured by G3LDO. Position 0 is the end of the coil. The negative position number represents distance from the end of the coil.

Position (cm)	Inductance (μH)
-3	135.0
-2	134.2
-1	131.4
0	126.0
1	125.0
2	113.6
3	104.3
4	103.2
5	103.5