Effect of a "tuning loop" on inductance and Q

May 2018

In older equipment (circa WWII) we occasionally see coils with a small loop or disc in the interior. These are in effect floating short circuited (s/c) turns used to adjust the value of the inductance. If the loop is transverse to the coil axis the effect is maximized. If the loop is rotated so that the plane of the loop is parallel to the axis of the coil, the effect is minimal. This seems like a very simple way to make a variable inductor. It looks a lot like a variometer except there is no electrical connection to the coil winding, the loop just floats.

While we know that this does work I wondered how it effected the Q of the inductor so I took the direct route of measuring the Q of a typical LF-MF antenna tuning inductor with and without a "tuning loop".

Figure 1 shows the inductor and the instrument arrangement.

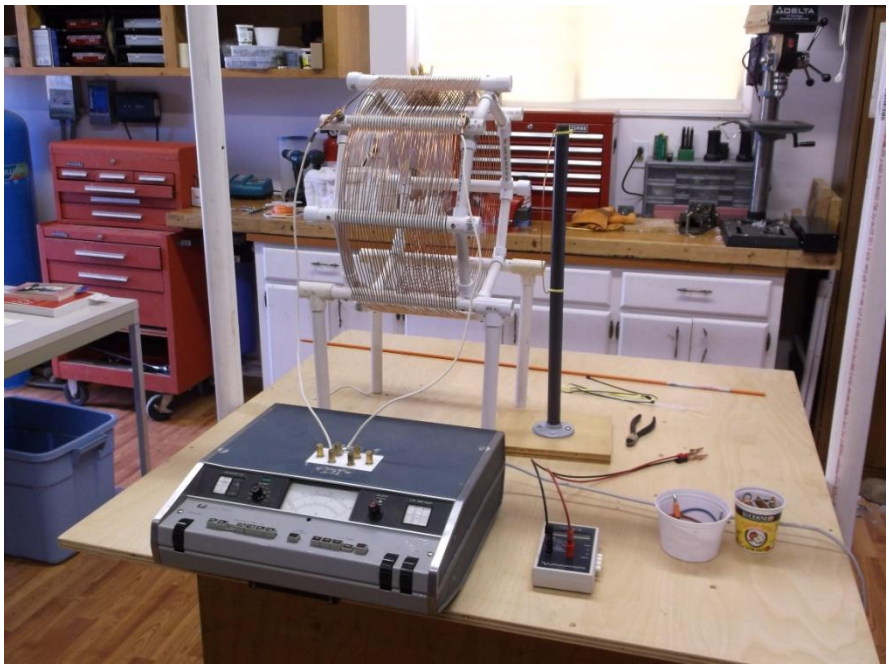

Figure 1 - Test inductor and experimental arrangement.

An HP4342A Q-meter was used for Q measurements and an AADE L/C Meter IIB for inductance.

Step one was to measure the inductance and Q of the bare inductor at 475 kHz:

L=836 uH and Q=735

Obviously a high quality inductor.

Step two was to measure the effect on L and Q of a s/c turn. Using a copper clip I shorted an end turn and a pair of turns near the center with the following results:

End turn shorted - L= 675 uH and Q=245

Middle turns shorted - L=514 and Q=110

A shorted turn significantly reduced the inductance but the most important effect is the drastic reduction in Q. This very bad news!

The next thing I tried was a floating 12" diameter #12 copper loop placed close to one end of the coil with the following results:

L=810 uH and Q=580

This represents about a 3% reduction in L but 21% drop in Q. I also tried smaller loops (5" diameter) inside the coil which showed a 0.7% drop in L but a 7.5% drop in Q. Judging from these experimental results this method for adjusting inductance certainly works but grossly degrades Q.

These results also raise some questions on the Q of variometer inductors. In that case the loops are usually multiple turns but are not s/c. However, in the minimum inductance position for the inner coil, we still have field bucking which is part of the Q loss problem. I think I may need to expand this note in the future to include a detailed explanation for the loss increase (i.e. Q reduction) and experimental data for a representative variometer!!