My "Magnetic Loop" project. (Started in dec 2008)

Many hams are using a "magnetic loop" antenna. So I got curious and started collecting information about this antenna. The Internet is a great source. After some calculations with "loopcalculator.xls" I decided to go for a 1.8 - 7 Mc loop capable to run 100 Watts.

A loop with a diameter of 400 cm is the goal. The Loop calculator showed me I needed a vacuum variable capacitor of 25-600 pF/5KV.

On Ebay I found my cap... 15/750 pF - 5KV 15 meter, 22mm copper tubing was ordered...

January 2009...

I want the copper tube to be a perfect loop so I made a simple tool:

http://www.pa0kv.nl/magnetic_loop.html
Then I started with the motor drive, 4mm spindle to control the slide-potmeter and the end-switches.

Lucky I have a metal lathe...

May 2009....

Here some pictures of the whole assembly. As isolator (and for alignment) I used a piece of rubber tubing.
(See the clamp on the rubber tubing to hold it on the drive-shaft. The rubber tubing fits tightly on the cap so I don't need a clamp and it works like a friction link in case the end-stop micro-switches mal function.

Looks good doesn't it!

All copper pieces are put together by brazing. The green plate I used is Trespa (a strong kind of Pertinax), 8 mm thick.

All bolts, nuts and washers are Inox. I need 4 wires for control of this unit. 2 for the DC-motor (turning left or right) and 2 for the potmeter.

http://www.pa0kv.nl/magnetic_loop.html
Next thing to do is bending (rolling) the 22mm copper pipe and the cap-unit enclosure is to be made.
To be continued...... PA0KV

May 10, 2009
Bending the copper tube.

The intention was to push the tube between the three wheels and adjust the middle wheel bit by bit to reach the radius I wanted.
But the copper tube did not want to be pushed around.
So I had to change the bending tool. I added a little swing handle.

First I drew a half circle with a 4 meter radius on the ground. Some crepe tape made the pencil drawing more visible.

The bending tool had to be mounted high enough for the tube to hang freely.
How do you mount a 4 meter loop vertical? I choose for a Y-joint and some 36mm surplus epoxy tubing (military tent sticks) which are 120 cm long and can be stacked together. I glued them with two-component polyester.
A Y-joint made from Inox tubing.

The whole assembly.
Loop is fed by a gamma match.

Picture speaks for itself. (80m)

>> Part 2

http://www.pa0kv.nl/magnetic_loop.html
Finished you think? Well, not quite.
The weight of the vacuum cap with mounting plate, motor drive, etc. was too much for this Y-construction.
The cap-assembly + enclosure needed support.
So I decided to go for a + -construction...
... to be continued...... PA0KV

Busy day today... may 29, 2009....

Creating the + - joint was easy using a piece of Trespa and bending some aluminum strip.
The white stuff in the middle of the epoxy tubing is glue.
The new assembly...

The vacuum cap has to be 'all weather proof' ...
... here the 160 mm PVC enclosure with glued PVC support to fit on the epoxy tube.

Another thing was keeping my mind busy.

How to mount the cap-assemble into its enclosure without drilling holes in it? Holes would make it less 'all weather proof'. Well, after another cup of coffee and some serious 'number-crunching' I came up with this....

http://www.pa0kv.nl/magnetic_loop.html
To be continued... 11 June 2009...

This is the idea... turning the cable-tensioner will push the doorstop upwards and the base-plate downwards.

Okay, let's put it up......

Two high tech equipment in one picture.....

http://www.pa0kv.nl/magnetic_loop.html
Final position.  

Shack view on the loop

Now I’m testing it... first rapports from PA-land on 80 and 160 where very good.

May 2013.
Designed with the loop-calculators on the web it should tune on 160, 80 and 40M.
But in practice the loop has to be a little bit smaller in diameter to tune it on 40M. Too much L in the circuit in this setup.

Bandwidth.
On 80M, tuned 1:1 with the vacuum cap, bandwidth is +/- 5.5 kc, swr 1.5:1
On 160M, “” +/- 1.1 kc, swr 1.5:1

The vacuum cap is a 5KV type so 100 watts is save.
In compare with my Inv-V on 80m there is little or no difference in send and received reports. (Local European contacts.)
But the Loop is much more quiet and no splatter from nearby stations.

73’s, Twan - PA0KV
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September 2015

Time to add another chapter to this loop story :-)
The Loop is working fine, but two things are bothering me.
1- The loop was meant to span from 160 to 40 meter. Unfortunately the loop can’t be tuned to 40m.
2- The tuning via a DC motor with some up and down buttons is a hassle.

To solve problem 1. the loop has to be made smaller. Less ‘L’ so I get more headroom in the high band (40m).
I have plenty of ’bottomroom’ on the lowest band (160m).

To solve problem 2. I need a very accurate and easy to control Vacuum Cap driver. A stepper motor has both!
But, for a stepper motor a control program is required.... And such a program for this application or not available.

I started searching the web for ‘off the shell’ stepper motor controllers,
Most of them have no smart logic on board and all the control you have to build (program) yourself.

But I found a board called ”Motor Hawk” which has USB control and is delivered
with a dll for all the actions towards a stepper motor.
It comes with a CD with the dll and very useful program examples in C++
and Visual Basic.

Here the small controller board, developed and sold by PC-Control in the UK.
It’s a 4-phase Bi-Polar (or hybrid) stepper motor (or two DC motors) controller
and can handle up to 36V-2A/fase.
There are also 8 digital inputs and 5 digital outputs available for general use,
with 4 of those inputs configurable as automatic limit switch inputs for motion control applications.

http://www.pa0kv.nl/magnetic_loop.html
Here the updated vacuum C control with the stepper motor.

It's a lot simplified. No end-switches, no position potentiometer. The stepper motor is a gift from a friend, PE1BWK. (Tnx Sjell!) The tooth belt and tooth pulleys are not hard to find on the web.

Here you see the board in its enclosure. At first I wanted to mount the controller near the Loop, so the motor wires remained short. But then I would need a 15 meter long USB cable. Not recommended. In addition, the controller also needs a DC power supply** of a few amps to feed the stepper. So I decided to keep the controller in the shack and connect the stepper motor by a 4x 1.5 mm² cable.

**) My stepper, a Minebea 23LM-C303-05, needs 3.5V - 1.4A/phase. I had an old Philips power supply, 12 Volt - 3Amp, perfect for the job. With 12V, two shunt resistors in the motor leads are needed, generate a lot of heat. :-( So I calculated the voltage drop across the 15 meter long leads, added the voltage drop of the board and adjusted the output voltage of the supply accordingly (+/- 7 Volt).

Digital switching produces RFI. Something we do not like. :-( This board is no exception. I installed a 100nF ceramic capacitor between each motor output and ground (0V). The wires are wrapped five times through a ferrite toroid. Close to the stepper I also used a toroid core. The board is mounted in an alloy box (with lid) and grounded to the box with 100nF. The box itself is grounded via the mains ground. As a result, RFI is reduced by 95%.

(more testing to do...)

To write a controller program for this board it was "back to the classroom" for me. Although I had some programming experience, .... (IBM mainframe systems programmer) ....... that was ten or more years ago!

It took me a while.... I studied visual basic from MS.... (VS2013).....

... with lots of try and error.

Finally I managed.

http://www.p0kv.nl/magnetic_loop.html

The display shows the chosen memory frequency. Tuning by steps to fine tune for 1:1 SWR.

Init screen (tab). Program first needs to initialize the stepper board. (Searching the USB devices connected.)

With the stepper settings: stepper motor power range 0–250, stepping rate in ms and default tuning steps when Up and Down buttons are used.

Stepper power can be forced on (max) or off (zero) for test purposes.

The program uses 1 control file and 4 memory files (xxx.cfg). They are read at initialization when a stepper control board is found. Files are saved by the Actuation button and by the memory Store buttons.

I also made the loop smaller. It’s now 3.4 meter in diameter and is tunable from 1.75 to 7.3 MHz. Mission accomplished!!

Any questions? Mail me!

http://www.pa0kv.nl/magnetic_loop.html