So you want to build a magnetic loop?

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Magnetic loops can be constructed in many ways and Youtube has many videos showing how amateurs have constructed them, some with very good ideas. I saw one where a USA amateur made a hole in the roof of his expensive car and has a hula hoop wrapped in aluminium foil on top. Through the hole he has a lever with which he can raise and lower the antenna!

An early antenna made by AEA used a metal hoop that could be bent so that it could go through a hatch in a ceiling, and bent back into shape once inside the ceiling. I know that an amateur once won the sweepstakes contest using such an antenna, but I must admit his location was excellent.

To avoid losses, the loop part has to be constructed of material that conducts well, so copper and aluminium are popular choices. MFJ say that they weld their aluminium loop to the stationary plates of a butterfly capacitor to avoid resistive losses. I live in a retirement centre where unsightly antennas are not permitted, so my HF antennas are two magnetic loops, an MFJ that works from 10 to 30MHz and a home constructed loop that works from 3 to 10MHz. With these antennas, both out of sight as far as my neighbours are concerned, I can work the whole HF band except for 160M.

I am not keen on talking on the radio, so I mostly listen or work digital modes, and using JT65 I have received signals from South Korea, for all practical purposes on the other side of the world. I think that digital modes are ideal for amateurs who have antenna restrictions.

The best form for a magnetic loop is a circle but a square loop or octagonal shaped one, works well. Copper is the easiest to obtain and also the easiest to solder the joints but in my local hardware store I see they have 2,5metre lengths of aluminium strip, from about 13 to 50mm wide. It immediately sparked my interest because I already have a spare vacuum capacitor just right for a magnetic loop. It is easy to bend aluminium strip into a circle, and it is also easy to overlap the ends in order to adjust the diameter of the loop, and just bolt the ends together with enough bolts and nuts. In this way I can probably throw together a magnetic loop in a very short time.

It crossed my mind that by overlapping the strips I can make a capacitor and so tune the loop. Look at this cunning idea that you can see on Youtube:
https://www.youtube.com/watch?v=hWbfuF6ti2I

It is obviously made of welded tubing with one half hinged at the bottom with the box-like structure at the top being the tuning capacitor. In the middle is a motor that turns a lead screw and the two halves of the loop move apart to tune the loop.

K8NDS posted videos of his helically loaded magnetic loops here:
https://www.youtube.com/watch?v=2YpyLAULKqg

I used this design for my low frequency loop because the helical winding adds inductance to the loop, enabling it to tune lower in frequency than a loop made of copper tubing or metal strip. My loop that tunes from 3 to 10MHz, is about 1,6M diameter but behaves like

a loop of about 3m in diameter. It is so easy to get some PVC tubing and elbows that enables one to make an octagonal loop. You just have to
cut the straight pieces to length, lay it on a flat surface and glue them together using PVC cement. Here is a picture of my loop:
Getting the copper strip is a problem. I was fortunate that a friend had some copper strip from transformer windings that he gave me. It took an eight meter length to wind my loop. One can buy slug tape on eBay that will work, but it is a bit thin and skin effect may come into play. But one could use two layers to increase thickness.

The tuning capacitor: Wherever possible I would recommend using a butterfly capacitor. These can be rotated through 360 degrees avoiding the necessity of end stops. But the voltage across such a capacitor is quite a lot, depending on how much power one runs. For receiving only, a capacitor with close plate spacing is sufficient. I see there is a video on Youtube where an amateur uses ceramic tiles with aluminium foil in between to make a fixed capacitor with high voltage specifications. I have also seen a capacitor with glass

between the plates to increase capacitance. The dielectric constant of window pane glass is around eight, giving eight times the capacitance as for one with air between the plates.

Many people go for vacuum variable capacitors for magnetic loop antennas. They have the advantage that they have a lot of capacitance together with high voltage ratings. But they have one disadvantage, the shaft for tuning the capacitor has to be rotated many times to go from minimum to maximum capacitance. The one on my magnetic loop needs 23 turns. One has to be careful not to damage the capacitor by turning the shaft too much.

I solved this problem by attaching a 10:1 gearbox to the shaft, and a three turn potentiometer, and then designing a circuit that indicates on a panel meter what the position of the vacuum capacitor is. The meter needed a non linear scale and I had to purchase a small program for printing meter scales to solve this problem.

One needs a motor to rotate the capacitor shaft and in the beginning I used a small 12V DC motor and gearbox that was intended for remote control of window curtains and similar installations. It was easy to implement because I only had to vary the voltage to vary the speed, and a switch to change the direction of rotation. Later I replaced the DC motor with a stepper motor and this was for this reason:

I found a posting on the Internet by Loftur Jonasson:
https://sites.google.com/site/lofturj/to-automatically-tune-a-magnetic-loop-antenna

My idea was to implement his design later on. In my opinion, the greatest disadvantage of the magnetic loop antenna, is the narrow bandwidth of the antenna, necessitating the retuning of the loop every time the radio's frequency is changed. But on the other hand, what other kind of antenna is there that can cover such a wide frequency band with such good SWR as a magnetic loop antenna!

There is another posting on Youtube by Tim, G4WIM that is interesting:

https://www.youtube.com/watch?v=lMzEijSj6G0

Tim also tunes his loop automatically but he also rotates the coupling loop to obtain perfect SWR and he illustrates this in his video. I found this interesting because I had struggled to get the SWR of my loop below 3:1. Until I came across another video by K9RLW:
https://www.youtube.com/watch?v=2RDtm6qXjuI
on improving the efficiency and SWR of a loop considerably.

It turns out that the position of the coupling loop is critical, not the other way round as many people state. K9RLW found that when he places the coupling loop close to the main loop, and deforms it so that a greater part of the coupling loop is closer to the main loop, it improves efficiency considerably. I promptly made a new coupling loop for my antenna, using 50mm wide aluminium strip instead of 6mm copper tubing and I get more signal from the antenna than before, and the SWR is now 1:1 on the 80 and 40M bands, 1:1 on 9MHz and 3,2 on 10Mhz, a great improvement. Here is a photo of my new coupling loop:

Whenever one designs a magnetic loop antenna, one needs to calculate some things. Use this program:
http://www.66pacific.com/calculators/small-transmitting-loop-antenna-calculator.aspx

Fill in the minimum and maximum frequency that you would like and other details and the program will tell you what is possible. It is not possible to have too wide a frequency range on one antenna, in my case I have to use two antennas to cover the complete HF band except 160M.

My MFJ antenna is inside a small back yard behind my house. The DIY low frequency loop stands inside my garage. I tried moving it outside but there was no noticeable change in signal strength. The MFJ's control signal goes through the same co-ax as the signal, but when one uses a stepper motor, more conductors are needed.

If one has enough space, I would choose conventional wire dipoles and Yagis above magnetic loop antennas but when you are in a restricted space or where antenna restrictions are in place, the magnetic loop antenna is a good compromise. I tried using the metal gutter and a loop antenna in my garage roof, but the magnetic loop outperforms them any day. My next loop will probably be mounted horizontally just under the garage ceiling. That way it will not take up any useful space at all!

Here is aphoto of such a loop courtesy WR5J: