Passive Antenna Re-radiators to function as Q Multipliers

Following a number of earlier email requests for passive antenna re-radiators to function as Q multipliers for improved radio reception I've decided to consolidate my replies into a web page. What may you ask is all this about?

The expression Q multiplier is not necessarily used here in its conventional sense by the way.

In some instances your radio receiver may be located in a most unfavourable location. This might be because you live in a hilly area, perhaps you simply live in a home where radio signals will not penetrate and your receiverdoesn't allow for the connection of an external antenna.

My 88 - 108 Mhz F.M. band radio made by Sanyo is one good example. It has a telescope antenna but my house is well insulated with an outer cover of aluminium foil and a metal roof. Signals from our favourite FM station simply don't penetrate the house particularly well and you get a "body" affect when a person moving around the room will interfere with reception. Depending upon where you stand the signal is either enhanced or reduced. By the way it has been demonstrated that the human body is a resonator at around 80 - 90 Mhz.

I simply erected a small length of wire across the top of the window, brought it down to near the radio and inductively coupled it to the receiver. The words inductively coupled are of significance to this topic. There is NO direct connection. I could have attempted to tune that coupling by resonating (peaking it as a Q multiplier) it at the desired frequency but this proved totally unnecessary as reception was completely adequate.

Resonator

A resonator is a combination of capacitor and inductor which resonates at its own natural frequency. It has the effect of accepting one signal while rejecting others. In the context of this topic we will use it as a sort of Q multiplier and inductively couple the signal to the receiver.

For our example let's consider a case where we have a typical A.M. receiver situated in a poor location. The receiver is of the type which uses a ferrite rod antenna for signal pick up. Your favourite radio station or, possibly the only radio station in your area is located at 810 Khz in the A.M. radio band. Don't worry about the frequencies for the moment because these principles apply to all frequencies and I'm just using 810 Khz as one example.

We will start with my own example from above where I didn't need a resonator, we will simply inductively couple an external antenna to our receiver. We can build upon or embellish that system as we go if it proves to become necessary.

Rule one for an external receiving antenna of this type, particularly for the medium wave am band - "erect it as long and as high as is physically possible". Obviously every individual situation varies. Just simply erect whatever you can conveniently accommodate. Having done that you continue to bring it into the house, shed, garage or whatever adjacent to the receiver.

Coupling to the receiver

How do we couple it to our receiver?

Method 1:

Obtain a piece of stiff yet thin material which is non-metallic - cardboard, thin ply, masonite or whatever. We are going to wind a spiral onto this. The spiral is wound from some thin gauge wire of the hook up variety but which is insulated. It will look something like this:

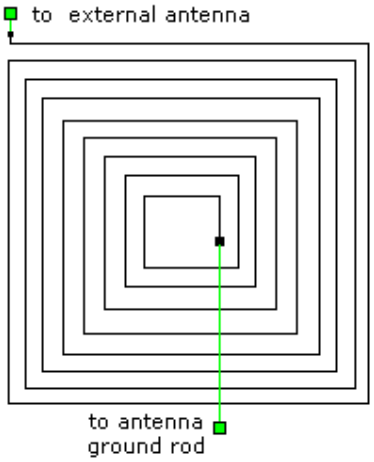

Fig 1. - Spiral Inductor

You will notice I have drawn this as a square, it equally could have been a rectangle, an ellipse or even a circle. The important point is that it is an inductor. We don't know its value (assuming you don't have an inductance meter) but the important part here is that each wire is separated from the other by say 3 wire diameters to help reduce self capacitance.

The actual shape will be determined by what will look O.K. underneath your receiver which presumably will be sitting on top of a table or cupboard. Hey! you have to make a lot of this up as you go along because every case is going to be individual and different.

Let's use my AM / FM / SW receiver as a test example (no not the real "hot" one - just a plain Sanyo radio /CD / tape unit). It measures roughly about 24" X 8" (700 mm X 200 mm). We cut a piece of ply to those dimensions, on one side (and this get messy) we coat it with glue, perhaps the PVA type and proceed to lay down our spiral leaving sufficient extra wire at both ends to come out the back behind the radio although figure 1 isn't exactly drawn that way. Leave it until the glue has set and is completely dry. Our spiral is now permanently stuck to the ply wood. We

might then cover the other side with some pleasing contact paper or possibly paint it so it looks visually pleasing so everyone else in the family is happy.

Next we connect the external antenna to one end and the other end goes to a piece of scrap metal pipe driven into the ground. The longer, the better. NO WE DO NOT USE THE ELECTRICAL EARTHING OR WATER SYSTEM FOR THIS PURPOSE - Repeat that again after me. It is dumb, it is highly dangerous to use an electrical earth. Provide you own independent ground. Do not listen to people who tell you otherwise for they condemn themselves with their own ignorance and yes I've known long experienced electricians who will tell you it is OK. Bull!, they are surely fools.

Having made those connections we place the board with the spiral facing the table or whatever and the radio sitting on top of the board. You have just inductively coupled the antenna to the receiver!.

Method 2:

Another variation on that theme is to build a box of suitable dimensions that has neither a top or a bottom, just the four sides. In this case we will not wind a spiral but instead a normal inductor around the sides of the box. My radio was 24" X 8" X 9" (W X D X H). The internal dimensions of the box would be 24" X 9" and the sides 8" wide (think about it). We wind the wire around the box to form a coil. Perhaps we then cover everything with contact to make it look good. Lay the box on its longest side, make the same connections as before, place the radio inside the box and away we go!

Method 3:

This is applicable to either method 1 or 2. We simply use a capacitor to resonate either of those inductors at our frequency of interest. Here is where it gets somewhat "iffy". I don't know the value of your inductance and neither do you unless you have a meter. What I can tell you is this. The combination of inductance (denoted "L" and in uH) and capacitance (denoted "C" and in pF) is determined by this formula:

L * C = 25,330 / (F * F) where F * F means frequency [always in Mhz] squared

Using my earlier example of 810 Khz (which is 0.81 Mhz) we get:

L * C = 25,330 / (0.81 * 0.81) = 38,607

Assuming our inductor measured out to say 250 uH then the required resonating capacitor would need to be 38,607 / 250 uH = 154 pF. Here I would use a fixed 150 pF capacitor, perhaps even 120 pF to allow for stray capacitance. Even though we do get a peaking or Q multiplier effect, the tuning would still be quite broad anyway and there is also stray capacitance. Don't get too paranoid about accuracy. This capacitor connects from the antenna connection across to the ground connection.

For you dear reader it'll largely be a matter of "suck and see". You could try using a variable capacitor, cheaper yet see if you can obtain a reasonable selection of fixed capacitors and try the old "substituting" method until you get improved results. As I said everyones situation will be quite different.

Antenna tuner

This is always worthwhile especially for SW receivers. You can't beat a reasonable antenna tuner. Here we will use a very basic "L" type network which is depicted in figure 2 below but be aware because we are dealing with totally unknow impedances it is purely experimental. Back to the old "suck and see". Hey! that's half the fun, experimentation.

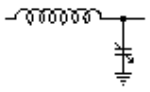

Fig 2 - L network tuner

Here we simply have an inductor and a variable capacitor. For the inductor I'd suggest you look at the method of construction I outlined in my tutorial on crystal radio sets. It's easy to construct, has suitable taps and that topic could give you suggestions regarding the variable capacitor.

Over the hill TV / FM reception

Bothered by a hill in your way? Try this method of passive antenna re-radiation. At the top of the hill you erect a suitable mast with two antennas. One antenna points toward the distant transmitter, the second antenna points toward your home antenna. Both antennas are connected together with either coaxial cable or 300 ohm ribbon. There will be significant losses in this process but assuming there is a strong signal at the top of the hill you will likely receive a satisfactory usable signal at your receiving antenna.

Conclusion

In all the methods discussed here we have not used one bit of power, the passive antenna reradiators are free. Excepting the last exercise with TV or FM antennas the costs involved are very minimal, a few dollars. Give it a try!

That's about it for now but if sufficient genuine interest is generated maybe I'll expand on the ideas and go further.