MW And LW Noise Reducing Antennas

Dallas Lankford

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Noise reducing antennas (also called interference reducing antennas) were originally developed by F. R. W. Strafford in the 1930's and then rediscovered and redeveloped by Denzil Wraight in the early 1990's. Some of the information contained here appeared in two articles written by Denzil Wraight and me during the summer of 1991 and published by The National Radio Club in their bulletin, ***DX News***. (Interestingly, a few years later a crippled commercial coax lead-in version of Strafford's antenna transformer appeared, called the Magnetic Longwire Balun.) A digitized copy of my article is given below in the appendix of this article. Reprints of both articles may be purchased from The National Radio Club at their web site: www.nrcdxas.org/catalog/reprints/ .

My main contributions to the rediscovery of Strafford's noise reducing antennas at that time were to develop antenna and receiver matching transformers which used Amidon ferrite toroids (Denzil's transformers used Siemens toroids), to investigate the noise reducing properties of Strafford's antennas at my location, and more recently to investigate variants of Strafford' noise reducing vertical antennas.. Denzil found Strafford's original articles in the early 1990's, developed the first modern Strafford antennas at his location in Germany, and informed me of his findings so that I could follow in his footsteps.

Strafford's antennas do not reduce noise by being remotely located (far away from your house), which was proposed at about the same time as a method for reducing noise. But as pointed out in my appendix article, locating a Strafford noise reducing antenna 50 feet away from my house had almost no affect on the amount of noise reduction. Strafford's antennas are inherently noise reducing and may be located near, even within a few feet of, your house. You should, of course, locate any antenna as far away from power lines as possible. Later it was claimed that the noise reduction of remotely located antennas with coax lead-in was due to separating the ground of the primary antenna transformer from the receiver ground and/or coax ground. However, I have found that separating those grounds only slightly reduces noise, if at all, for Strafford antennas with coax lead-in, both inverted L and vertical antennas. And Hall-Patch and Bryant found no evidence of noise reduction by separating grounds for beverage antennas and coax lead-in according to their ***Proceedings*** 1988 article.

Figure 4 below is from one of Strafford's articles. I have used the more elaborate receiver transformer (balanced centre-tapped and shielded) on several occasions, but it has never given me any additional noise reduction. The simple receiver transformer version of Figure 4, without the center tapped receiver transformer, and without shielding between the primary and secondary of the receiver transformer, is what I have always used. It has typically given 10 to 15 dB or more noise reduction in the 100 kHz to 2 - 3 MHz frequency range at the houses where I have lived.

Here is what I wrote in my appendix article below about 10 years ago. "According to Strafford, these kinds of noise reducing antennas are most effective against nearby noise, i.e., against noise which originates in your house or apartment, in nearby houses, in nearby power lines, and so on. Noise which will be reduced or eliminated includes, but is not limited to, TV horizontal oscillator harmonics (HOH) and associated noise sidebands, fluorescent light noise, air conditioner compressor motor noise, air conditioner fan and heater fan noise, power line noise, and vacuum cleaner motor noise. The amount of reduction depends on the type of noise, the location of the noise source relative to the antenna, and perhaps other factors. Strafford said that noise reduction with a vertical noise reducing antenna was 30 to 100 (30 dB to 40 dB), but he did not specify what antenna his noise reducing antenna was compared to. In my experience, the amount of noise reduction (both with my inverted L and with a 30 foot vertical noise reducing antenna) is not as great, namely 3 to 56 (10 dB to 35 dB)compared to my original inverted L. With my noise reducing inverted L, fluorescent light noise was reduced 10 to 15 dB, TV HOH and associated noise sidebands were reduced about 15 dB, air conditioner compressor motor and AC/heater fan motor noise were virtually eliminated, power line noise (60 Hz harmonics) were reduced to the threshold of detectability, vacuum cleaner motor noise was reduced more than 30 dB and virtually eliminated, and assorted regular noise "pests" of undetermined origin were reduced 15 to 25 dB. There is now only one irregular "pest" which ruins daytime MW listening, a 40 dB + monster which used to "kill" the entire MW band except for strong locals. It is still a serious problem even though it has been reduced about 20 dB. Fortunately it does not appear often, and never at night. Curiously, it is my only remaining noise source where nulling it with my loop will produce clearer weak signal reception than the noise reducing inverted L."

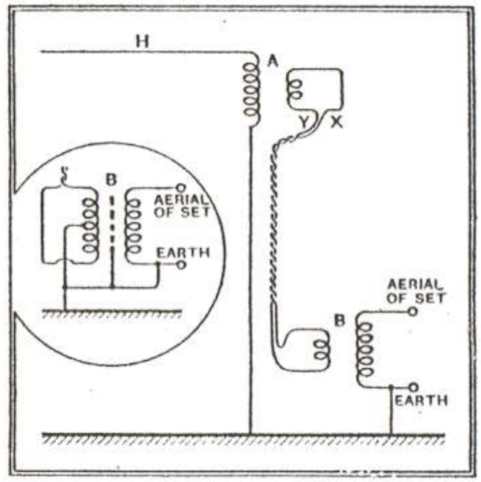


Fig. 4.—Similar arrangement to that of Fig. 3, but with the down-lead screen replaced by an earthed wire. Inset : a balanced centre-tapped transformer.

A few things have changed since the above was written. I never hear TV HOH any more. I don't know why. Maybe my neighbor or I had a noisy TV years ago. Or maybe TV's don't radiate as much HOH nowadays. But now I often hear digital noise which originates from some of my switching power supplies (laptop computer, inkjet printer, wireless network, etc.), as if to make up for the vanished HOH. My switchers are heard in and around the MW band only when ambient power line noise drops to low levels, but are heard regularly above about 10 MHz. When present, my switcher noise is heard approximately every 65 kHz. My noise reducing antennas reduce but do not completely eliminate digital noise at lower frequencies. At higher (above about 6 MHz) frequencies my noise reducing antennas do not reduce digital noise at all. In both cases, to completely eliminate switching power supply digital noise the switchers must be unplugged from the wall socket.

For a few years I used a noise reducing inverted L antenna as my primary MW antenna, both stand alone, and together with a 2 foot air core loop antenna as part of a phased array using simple phasers I developed. Then, beginning about 10 years ago, after I built my first Misek phaser, the loop antenna was retired and I used a phased array based on a pair of noise reducing inverted L antennas separated by about 150 feet. As a precaution against intermodulation distortion, I shortened the horizontal elements from the 65 feet specified in my appendix article to 30 feet. Despite what many people believe, bigger (longer) is usually not better, unless you have very low levels of man made noise. If you can hear man made noise clearly (and I do not mean 20 over S-9 of man made noise), your antenna is long enough. At that time I experimented briefly with noise reducing vertical antennas, but concluded that the signal output was unacceptably low for phased arrays. There matters remained until a few months ago when I gave noise reducing verticals another try. Figure 5 below is what Strafford recommended for a noise reducing vertical antenna, and probably similar to what I implemented about 10 years ago.

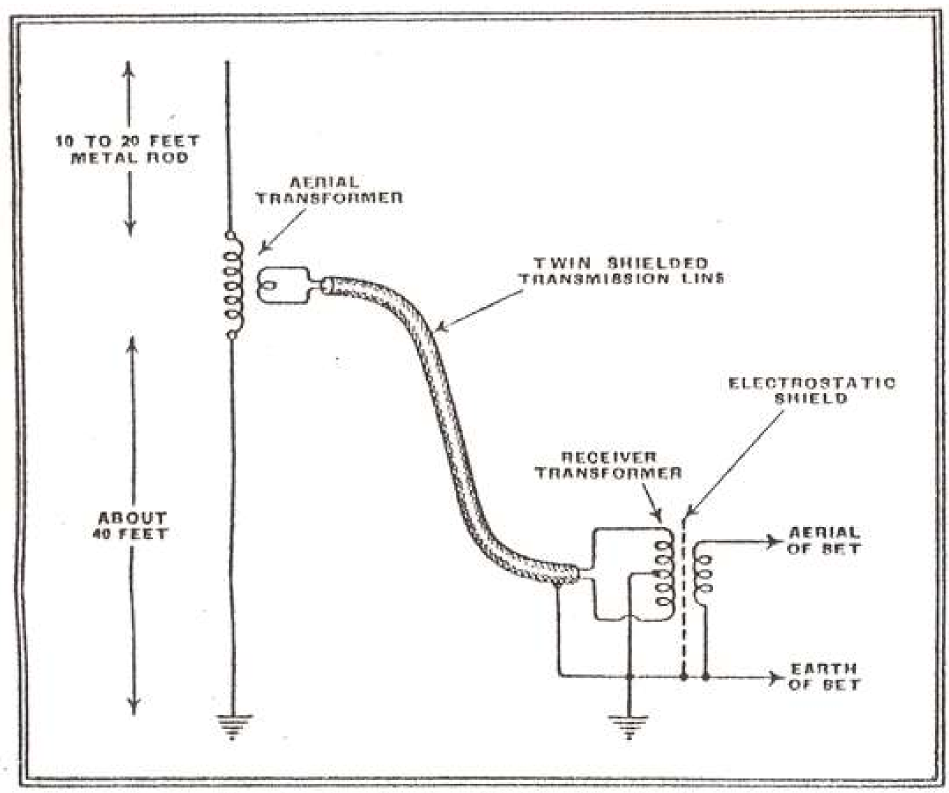
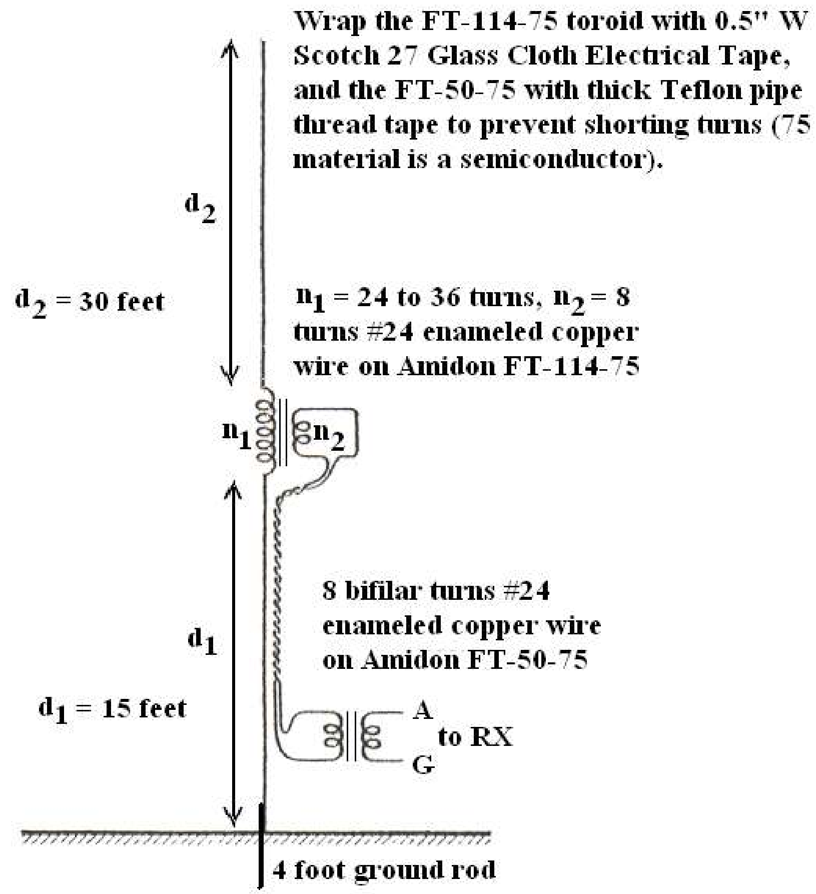


Fig. 5.—Circuit of typical vertical anti-interference aerial.

However, this time I did not copy Strafford's Figure 5 exactly. Instead of locating the antenna transformer near the top of the vertical antenna, I located it near the bottom, about 15 feet above the ground rod, and used 30 feet of wire above the antenna transformer; see below.



My New Noise Reducing Vertical Antenna

As a matter of fact I used one of my inverted L's and some 1/4 inch diameter nylon rope to hoist the vertical contraption over a high branch of a pine tree in my yard. The nylon rope was pulled over the high branch with 20 lb test fishing line which had been shot over the limb using a 2 ounce lead sinker and sling shot. The 15 foot height of the antenna transformer permits the twin lead to be run high enough above ground level so that people can walk underneath it. I briefly tried a balanced center-tapped receiver transformer and electrostatic shield with one of my verticals which Strafford recommended, but it gave no additional noise reduction compared to the simple 8 turn bifilar transformer which I normally use.

Signal levels for this 15'v+30'v noise reducing vertical antenna have been excellent, greater than my 15'v+30'h inverted L's. The verticals reduce noise at least as well as the L's in all cases, and for some daytime groundwave signals my new verticals reduce noise up to 10 dB more than the L's. Eventually I may reduce the heights of my verticals to minimize potential intermod because the signal levels are greater than necessary at my location. My new noise reducing verticals also have better long term null stability for daytime groundwave signals than my noise reducing inverted L's, and work equally well with my big air core loop antennas for LW nulls. It is difficult to say if the phased verticals have better long term null stability for nighttime skywaves than phased inverted L's because of inherent differences (polarization, etc.) between verticals and L's; in any case, the verticals seem no worse for skywaves. Consequently, my inverted L's have been retired, and my new noise reducing verticals spaced 150 feet apart are my primary phased array for MW. For information on the phasers I use go to The Dallas Files at www.kongsfjord.no .

The turns ratio of the antenna transformer of my new noise reducing vertical antenna may be anything from 3:1 (9:1 impedance ratio) to 4.5:1, or even 5:1. The vertical antenna transformer may be mounted at the ground ($d_1 = 0$). I chose $d_1 = 15$ feet because is was easy to reach by ladder to provide strain relief for the twin lead (by tying the twin lead to the trunk of the tree). I have found no difference in noise reduction between mounting the antenna transformer at the ground or 15 feet up.

As pointed out in my appendix article below, the amount of noise reduction of a noise reducing inverted L begins to fall off above 2 or 3 MHz with little, if any, noise reduction observed above 6 MHz. For a short wave noise reducing antenna Strafford recommended a 40 foot (horizontal length) doublet. Two versions of Strafford's noise reducing short wave antenna are given in his Figure 6 below. I briefly used two versions of Figure 6 in the 21.5 MHz band for experiments with HF phased arrays, but did not investigate their noise reducing properties. There have been some claims of noise reduction at SW frequencies above 6 MHz using coax with an inverted L instead of twin lead, but that is doubtful for reasons given by Strafford, and I have not observed any such noise reduction.

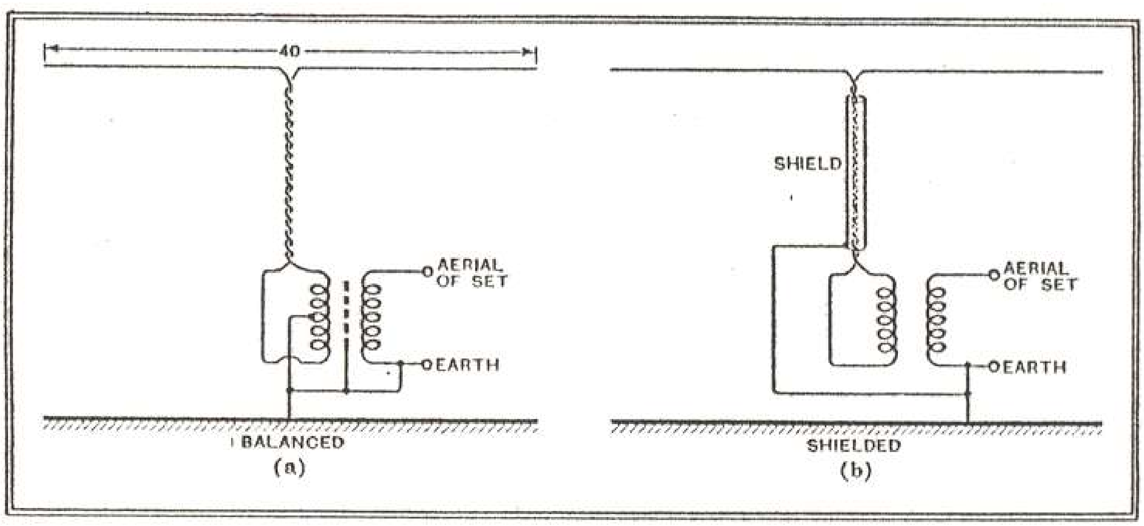


Fig. 6.—Balanced and shielded anti-interference aerials for short-wave reception.

Appendix

Inverted L Noise Reducing MF/VLF Antennas

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If you could reduce all of your regular MF noise sources and pests by 10 dB to 35 dB and your VLF noise even more for an outlay of two ferrite toroids, some Teflon pipe thread tape, 25 to 50 feet of zip cord, and an 8 foot ground rod, wouldn't you convert your inverted L to a noise reducing inverted L antenna?

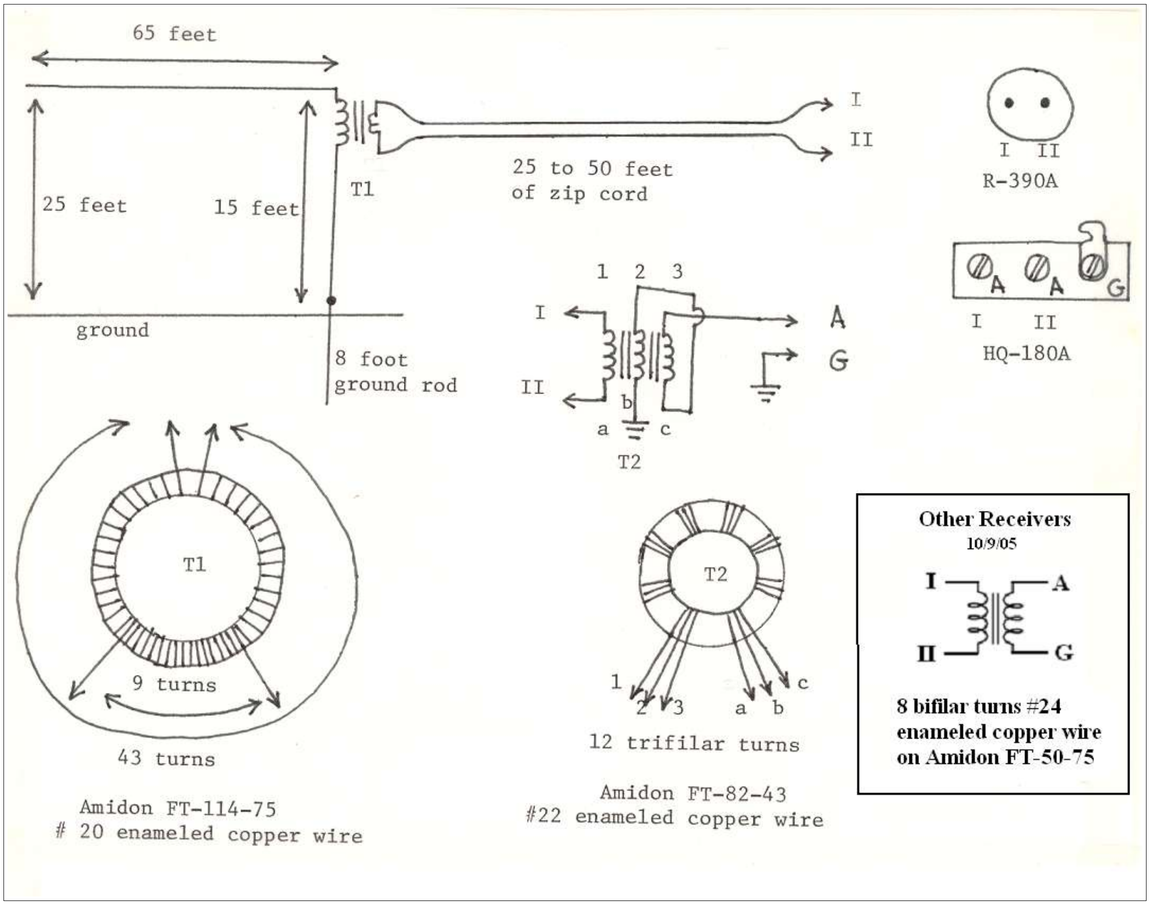
Recently I have been experimenting with some remarkable noise reducing antennas for MF and VLF reception. My current inverted L version of these noise reducing antennas is shown below. I was introduced to these antennas by Denzil Wraight who informed me of the ***Wireless World*** articles by F. R. W. Strafford, "Screened Aerials," Nov. 25, 1937, pages 516 - 518, and "Vertical or Inverted 'L' Aerials," June 22,1939, pages 575 - 577. Denzil also sent me details of the antenna transformer T1 which he designed. The toroid he used, a Siemens B64290K0618X830, is apparently not available in the USA, so I designed an equivalent transformer using an Amidon FT-114-75 ferrite toroid.

My inverted L has a 65 foot horizontal section, one end about 15 feet up at the roof of my house, the other end about 25 feet up at a telescoping TV mast, guyed opposite the direction of the horizontal section. If you already have a longer and/or higher horizontal section, you may use that. I included the dimensions of my inverted L to give you some minimum dimensions for adequate signal levels. An 8 foot ground rod is sunk in the ground directly below the low end by the wall of my house. Use #18 or 16 copper wire to connect the ground rod to the primary of the antenna transformer Tl. It is a good idea to use some kind of strain relief for mounting the antenna transformer Tl. High wind can whip the antenna around and eventually break the transformer leads. All of the connections were soldered. Merely twisting bare wires together is not a good idea.

The zip cord may be # 18 stranded lamp cord, speaker wire, or true zip cord. Since the zip cord should be soldered at the secondary of the antenna transformer Tl, you should make sure that both wires of the zip cord pair are copper. With some speaker wire, one of the pairs is stranded aluminum wire. Although I specified 25 to 50 feet of zip cord, you may use up to 100 feet of zip cord. For longer lengths of zip cord, you may need to retune the front end of your receiver.

If you use an R-390A or HQ-180A, you may connect the ends (I and II) of the zip cord directly to the balanced antenna inputs as shown. Be sure to remove the shorting link between the G and adjacent A terminal of the HQ-180A as shown. For unbalanced antenna input terminals, or for use with a VLF converter or accessories such as a phasing unit, you will need an antenna matching transformer.

My current antenna matching transformer T2 is an Amidon FT-82-43 ferrite toroid wound with 12 trifilar turns of # 22 enameled copper wire. The three wires are wound side by side as shown. As shown, T2 is a balanced to unbalanced 1:4 step up transformer. For some receivers a 1:1 bifilar transformer may provide adequate signal levels. If you use the antenna with other receivers, you should try both antenna transformers and use the one which gives best signal levels.



The antenna transformer Tl is wound on a ferrite toroid made from 75 material, which is a semiconductor. Thus precautions should be taken to prevent the enamel of the windings from being broken and making direct contact with the ferrite material. Otherwise turns of the windings will be shorted, and the antenna transformer will not perform as it should. To insulate the toroid I wrapped it with two layers of Teflon pipe thread tape, Harvey's brand, type T-l/2 6F - 12. Harvey makes both a thin Teflon tape and a thick Teflon tape. This is the thick Teflon tape. I discussed insulating the toroid with someone at Amidon and they suggested using glass cloth electrical tape (which they sell). A single layer of GC tape was satisfactory. As for weather proofing Tl, you are on your own. I haven't done anything. For the 43 turn primary you will need about 6 feet of # 20 enameled wire.

Fold the 6 foot length into two 3 foot halves, and start winding at the center of the primary, leaving enough space between turns (in both directions from the center) for the 9 turn secondary windings to fit in between the primary windings. After that, the remaining primary windings should touch each other on the inner circumference of the toroid.

There is just enough space around the inner circumference to accomodate all of the windings in a single layer. You may have to do some pushing on the primary turns to get the secondary turns flat in between the primary turns, especially at the inner circumference.

For the secondary winding a 3 foot length of # 20 enameled wire is needed. The 6 foot primary length and 3 foot secondary length will give ample excess for about 1 foot leads.

I used Teflon spaghetti to insulate the leads, and fixed the ends of the windings with plastic push-through cable ties. I also used a plastic cable tie to mount the finished antenna transformer to the edge of my roof (a short piece of 2 by 2 fir nailed to the facia makes a convenient tie point through a hole drilled in the fir) and another cable tie through a knot tied in the zip cord for zip cord strain relief.

When the inverted L noise reducing antenna described above is compared to an ordinary 80 foot inverted L antenna in the MW band, the noise reduction can only be described as amazing. In some 37 years of DXing the MW band I must have tried at least two dozen noise reducing schemes, and not a single one of the previous schemes had any effect on noise except for nulling a single noise source with a good loop antenna. The inverted L noise reducing antenna does not null noise because it is not a directional antenna; it reduces noise in all directions. According to Strafford, these kinds of noise reducing antennas are most effective against nearby noise, i.e., against noise which originates in your house or apartment, in nearby houses, in nearby power lines, and so on. Noise which will be reduced or eliminated includes, but is not limited to, TV horizontal oscillator harmonics (HOH) and associated noise sidebands, fluorescent light noise, air conditioner compressor motor noise, air conditioner fan and heater fan noise, power line noise, and vacuum cleaner motor noise. The amount of reduction depends on the type of noise, the location of the noise source relative to the antenna, and perhaps other factors.

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According to Strafford, for maximum noise reduction the antenna transformer Tl should be mounted where the horizontal part of the inverted L changes to vertical. I found no difference in noise reduction with the antenna transformer Tl mounted at the base of the vertical part of the inverted L. Nevertheless, I currently have my antenna transformer Tl at the "knee" of the inverted L as shown above just in case there is any advantage to that configuration.

I tried my noise reducing inverted L antenna briefly with a borrowed Palomar VLF converter and got as much or more noise reduction as for the MW band. I am not an experienced VLF listener, so I don't know how this compares with other VLF noise reducing schemes, such as remotely located active broadband whips,or loop antennas. However, I am sure VLF listeners will be pleasantly surprised by the performance of the noise reducing inverted L antenna.

Noise reduction begins to falloff in the 2 to 3 MHz range, and by 6 MHz there is little, if any, difference between the noise reducing inverted L and a standard inverted L antenna. Strafford discusses noise reducing doublet antennas for SW reception in the articles mentioned above. But I have not tried them.

With the noise reducing inverted L antenna perhaps 6 to 10 dB increase in signal levels has been observed at 15 MHz by reversing the zip cord lead connections (I and II) at the primary of Tl. After that adjustment was made, the noise reducing inverted L antenna was an excellent all band antenna, about as good as a standard inverted L antenna at the higher SW frequencies.

I have compared my noise reducing inverted L antenna with a noise reducing vertical antenna similar to the one described to me by DenzilWraight. When the vertical was mounted within a foot or two of the wall of my house, the inverted L was slightly quieter. When the vertical was mounted 50 feet away from the house, the vertical was slightly quieter. Thus it appears that some additional small amount of noise reduction can be obtained by optimizing the placement of the antenna. For my antennas and noise sources, the amount of additional noise reduction was so small that optimal antenna placement was not worth the effort. But that may not be the case in general. Since most DXers will have to compromize with regard to antenna placement, my recommendation is to do the best you can. Try to maximize the distance between your antenna and obvious noise sources, such as fluorescent lights, TVs, the AC power line to your house, and so on. The zip cord picks up little, if any, signal at low and medium frequencies, so it can pass near noise sources without contributing much, if any, to received noise.

I tried several variations on the noise reducing inverted L antenna described above, such as center tapping and grounding the center tap of the primary of the antenna matching transformer T2, and electrostatically shielding the primary of T2 from the secondary of T2. None of the variations reduced noise further, and center tapping the primary of T2 actually increased the noise slightly.

I would like to express my appreciation to Denzil Wraight for sharing his noise reducing antenna information and discoveries with me which made it possible for me to convert my inverted L antenna to a noise reducing inverted L antenna. I am convinced that these kinds of noise reducing antennas will be the wire antennas of choice for most MW listeners in the future.