# Half-Wavelength Interrupted Loops: Their Evolution and Uses

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Loop antennas, down to a size around 0.5-λ, still qualify as big loops compared to the "small" loop sizes that range from 0.25-λ downward. However, a closed loop with a circumference of about 0.5-λ has a very high feedpoint impedance value, often so high as to defy matching methods commonly available to the average amateur.

More manageable is the interrupted loop configuration. One difficulty with calling these antennas "loops" is that they are not so much shrunken resonant loops with a gap as they are derivatives of the common linear dipole. We tend to form them into a square loop shape mostly to obtain the convenience of using non-conductive spreaders to support the wire perimeter. However, the square shape is not electrically necessary to obtain a resonant dipole that occupies more area but less linear space than a standard dipole.
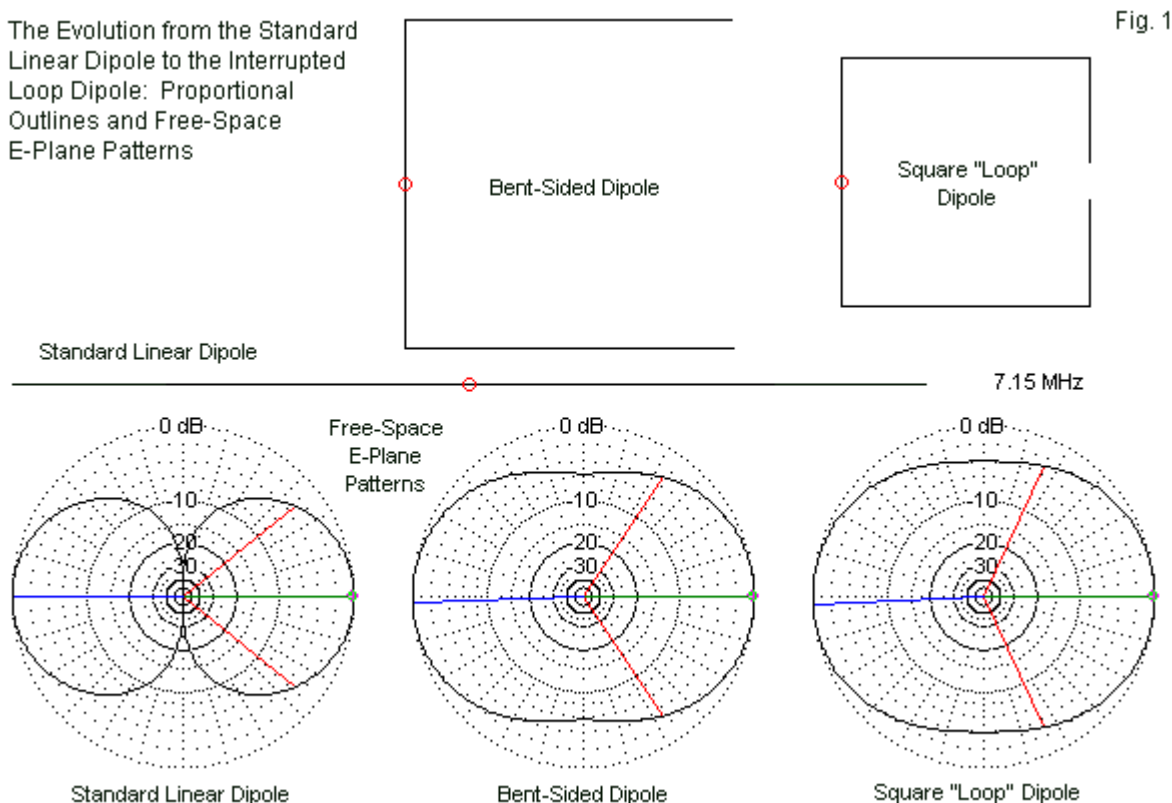
The Evolution from a Linear Dipole to a ½-λ Interrupted Loop

Fig. 1 shows one possible evolutionary progression from a linear dipole to an interrupted loop form. **Table 1** provides some data that explains the evolution in numerical terms. The figure shows the outlines of these antennas in proportion to each other. As well, the graphic includes the free-space E-plane patterns that show the increasing beamwidth that goes with the increase in dipole origami. Although the selected bent shapes are all squares, there is no limit to the possible shapes, such as a Z-configuration or a rectangular outline. For each set of bends, there is a dipole length that will yield a resonant impedance. As we increase the number

of bends and the interactions among parts of the dipole structure, the total wire required will increase, although only slightly if we do not use radical fold-back structures. The total wire in the interrupted loop 40-meter antenna is about 69.3' compared to about 66.9' for the linear version of the dipole.

Table 1. A 3-step progression from a linear dipole to an interrupted loop for a 7.15-MHz AWG #12 copper wire antenna using free-space performance values

Step Name	Side Length feet	Gap feet	Gain dBi	Beamwidth degrees	Impedance R+/- jX Ω
Dipole	66.86	---	2.07	78	73.2 – j0.1
Bent Dipole	23.0	23.0	1.01	112	24.1 – j1.1
Interrupted Loop	18.0	2.66	0.81	131	12.7 – j0.3

On major change occasioned by the dipole bending process is a reduction in the maximum gain, accompanied by an increase in the beamwidth. The side-wires of the bent versions show considerable current magnitude along their length, resulting is more gain where the linear dipole shows a deep null. Consequently, we find less gain in the "broadside" direction, using the linear dipole as a guide to what counts as being broadside.

The bending of the linear dipole into a U-shape or all the way to an interrupted loop results not only in a lowering of the feedpoint impedance, but also in a narrowing of the SWR bandwidth. By the time we reach the minimal square size feasible with a 40-meter wire dipole, the impedance is only about 17% of the impedance value for a linear dipole. **Fig. 2** shows the modeled SWR bandwidths of free-space models of each antenna relative to the resonant feedpoint impedance. Each step in the folding process results in a smaller portion of the band that the antenna will cover.

Fig. 2
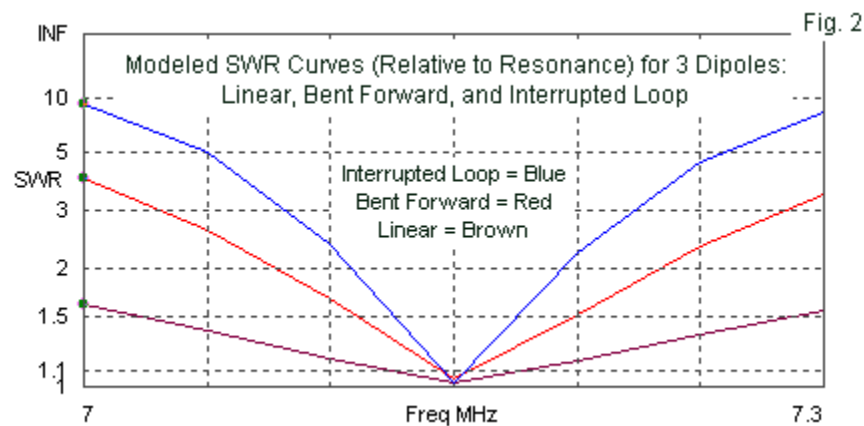
The urge to fold, bend, and mutilate a dipole arises normally from the need to fit the antenna into a small space. Circumstances often take priority over questions of gain and directivity. **Fig. 3** shows the comparative sizes of a typical linear dipole and a ½-λ interrupted loop for the same frequency. The 40-meter interrupted loop (and its slightly larger bent-side version) fit into yards less than 50' across. Some users prefer to accept less gain in exchange for the wider beamwidth.
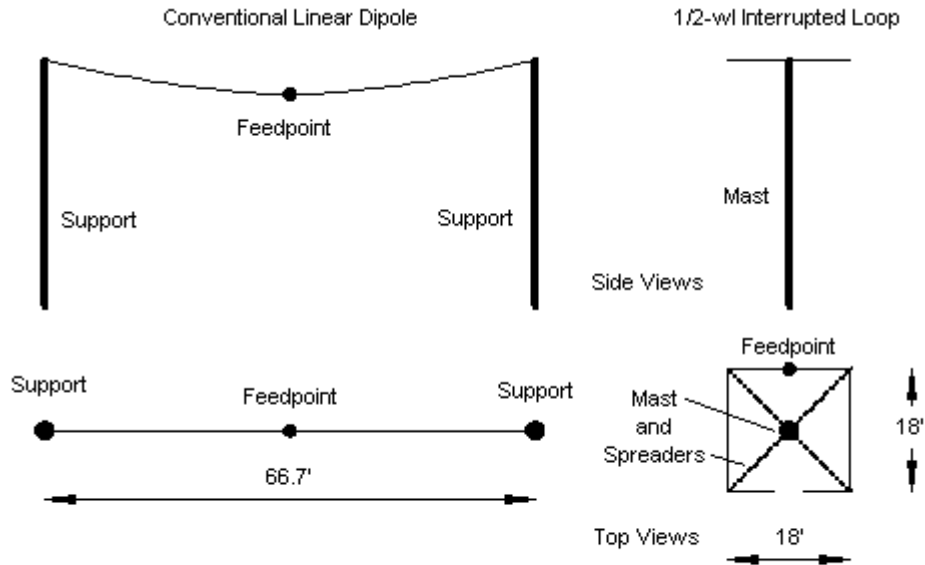
Conventional Linear Dipole

1/2-wl Interrupted Loop

Feedpoint

Support   Support

Mast

Side Views

Feedpoint

Support   Feedpoint   Support

Mast
and
Spreaders

18'

66.7'

Top Views   18'

General Proportions of a Conveitonal Linear Dipole and
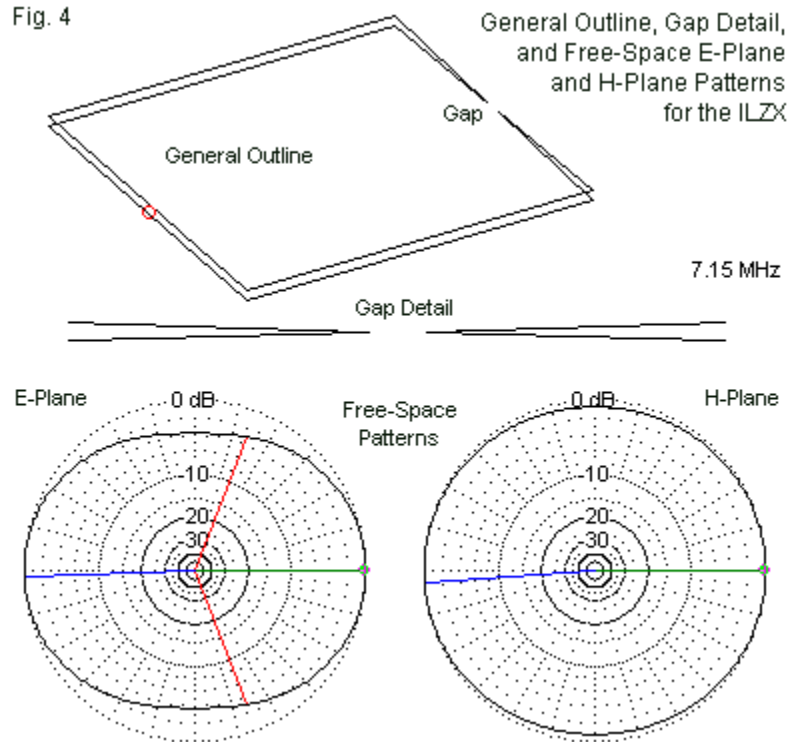a 1/2-Wavelength Interrupted Loop for the Same Frequency

Fig. 3

Current trends in antenna design tend to resolve the impedance issue with transformers. A 1:4 transformer of either conventional or transmission-line design will raise the impedance to a value close to 50 Ω. In many cases, builders simply use a 4:1 balun designed for a 50-200-Ω transformation to effect the required impedance change. Transmission-line transformers are most efficient when the characteristic impedance of the winding is the geometric mean between the impedance values at each set of terminals. Depending upon design, they may not be as efficient when pressed into service converting a 12-Ω impedance value to 50 Ω.

The ILZX Alternative

There are alternative geometries for the antenna itself that will yield close to a 50-Ω impedance directly without the need for an external transformer. For example, we may construct the small interrupted loop dipole using a folded dipole element bent to the desired square shape. **Fig. 4** shows the outline and the free-space patterns of one such design, dubbed the ILZX (Interrupted Loop, Z (impedance) X (transformation)).

The ILZX outline dimensions are identical to those of the single wire version shown in **Table 1**, except that the gap is only 1.12' wide. The wires are 6" apart to form the transmission line aspect of the antenna. On the side with the gap, the wires come to a point. There is capacitive coupling between the gap ends. The pointed configuration allows adjustment of the gap size with the least sensitivity to very small changes.
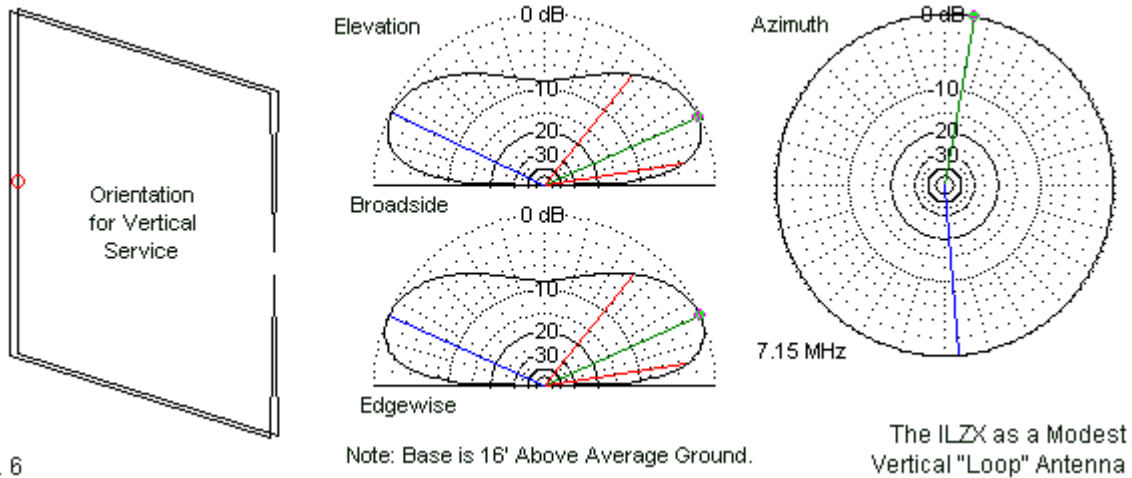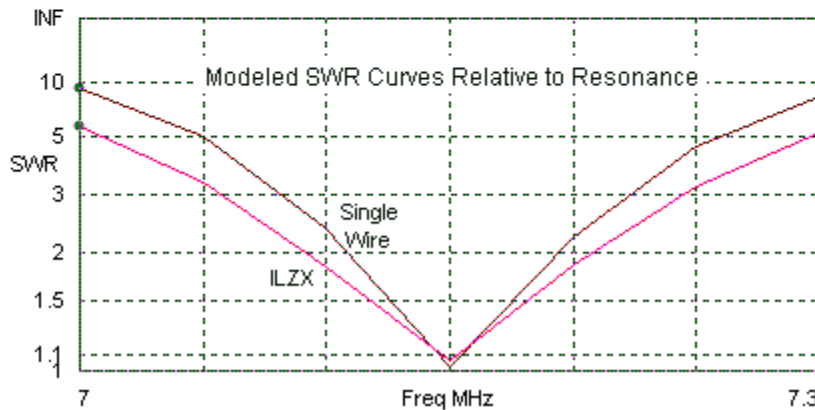
Because the paired wires that form the dipole have the effect of a single very fat wire, the gain of the ILZX is slightly higher than the gain of the single wire version: 1.01 dBi in free space. This increase is only of numerical interest, since it would be undetectable in operation. As well, the E-plane pattern in **Fig. 4** shows an increase in the beamwidth to about 137°. The H-plane pattern shows the very slight departure from the perfectly circular pattern that we associate with linear dipoles. The slightly oval pattern emerges with the bending of the dipole.

Fig. 4

General Outline, Gap Detail,
and Free-Space E-Plane
and H-Plane Patterns
for the ILZX

Gap

General Outline

7.15 MHz

Gap Detail

E-Plane   0 dB   Free-Space   0 dB   H-Plane
                          Patterns

Above average ground at a typical amateur-station 50' height, the 40-meter version of this antenna shows a normal elevation pattern, as shown in **Fig. 5**. Because the antenna is only about 3/8-λ above ground, the azimuth pattern is broader than the free-space E-plane pattern. In fact, the radiation off the antenna sides is less than 3-dB down from the radiation along the main axis running through the feedpoint and the gap. Therefore, the pattern shows no beamwidth lines. The maximum gain is just over 5 dBi at the TO angle, about 2 to 2.5 dB lower than a linear dipole.

Fig. 5 also shows comparative SWR plots for the modeled single-wire interrupted loop and the ILZX version. The folded structure prevents either version from providing full band coverage of 40 meters. Because the double-wire construction of the ILZX provides the equivalent performance of a wire much fatter than AWG #12, its SWR curve is wider. Nevertheless, the coverage is still less than half the band. On higher HF bands, from 30 through 12 meters, the coverage will be greater, since the bands are narrower.

The ILZX or the single-wire version of the interrupted loop dipole is also usable as a vertically oriented antenna for those with greater space restrictions. **Fig. 6** provides the general outline of the array. Since the major lobes in horizontal service are on the feedpoint-to-gap axis, the antenna is aligned for side feeding. The figure also shows the elevation patterns both broadside and edgewise to the array. In both directions, the TO angle is 24° with the bottom of the antenna at a height of 16' above average ground. The resulting azimuth pattern, shown on the right, is very close to perfectly circular at an average gain close to 0 dBi. This value is similar to the gain of a vertical dipole with its base relatively close to the ground. However, the vertical dipole will reach close to 70' above ground, while the ILZX top height is only 34' (18' above the base height). The vertical dipole, due to its higher feedpoint region, will show a lower TO angle (about 18°).

Fig. 5

Elevation and Azimuth Patterns
for the ILZX 40-Meter Antenna
at 50' above Average Ground

7.15 MHz

Elevation

Azimuth

Modeled SWR Curves Relative to Resonance

Single Wire

ILZX

SWR

INF
10
5
3
2
1.5
1.1
1

7   Freq MHz   7.3

Orientation
for Vertical
Service

Fig. 6

Elevation

Broadside

Edgewise

Note: Base is 16' Above Average Ground.

Azimuth

7.15 MHz

The ILZX as a Modest
Vertical "Loop" Antenna

The vertical dipole enjoys a significant advantage over the ILZX or any of the interrupted-loop dipoles when we consider the operating bandwidth of the antenna. The linear dipole will cover the entire band with an SWR of less than 2:1. The ILZX, despite its feedpoint impedance that is close to 50 Ω, will cover only about 125 kHz of the 300-kHz 40-meter band. Therefore, any builder would likely have to choose a favored segment of the band or resort to an antenna tuner to be able to work the entire band.

Despite its limitations of gain and bandwidth, the interrupted loop—either as a single or a double wire and either horizontal or vertical—performs quite adequately as a monoband

antenna for limited space installation. Some builders would like to use multi-band versions of the antenna, so we should spend a little time on the fundamentals of nesting at least two of these antennas.

Some Basic Properties of Nested Horizontal Interrupted Loops

If we can create a monoband interrupted loop based on the 1/2-λ dipole, then perhaps we can nest two or more of the antennas and end up with a multi-band antenna that requires no more space than a monoband loop for the lowest operating frequency. We might also be able to provide the loops with a common feedpoint and use a single feedline to serve all frequencies. Although these notes do not seek to provide a construction guide, perhaps we can uncover some basic properties of nested interrupted loops by exploring a few possibilities. Like the basic monoband design, we shall use single-wire loops with AWG #12 copper wire elements and use 7.15-MHz as the lowest frequency.
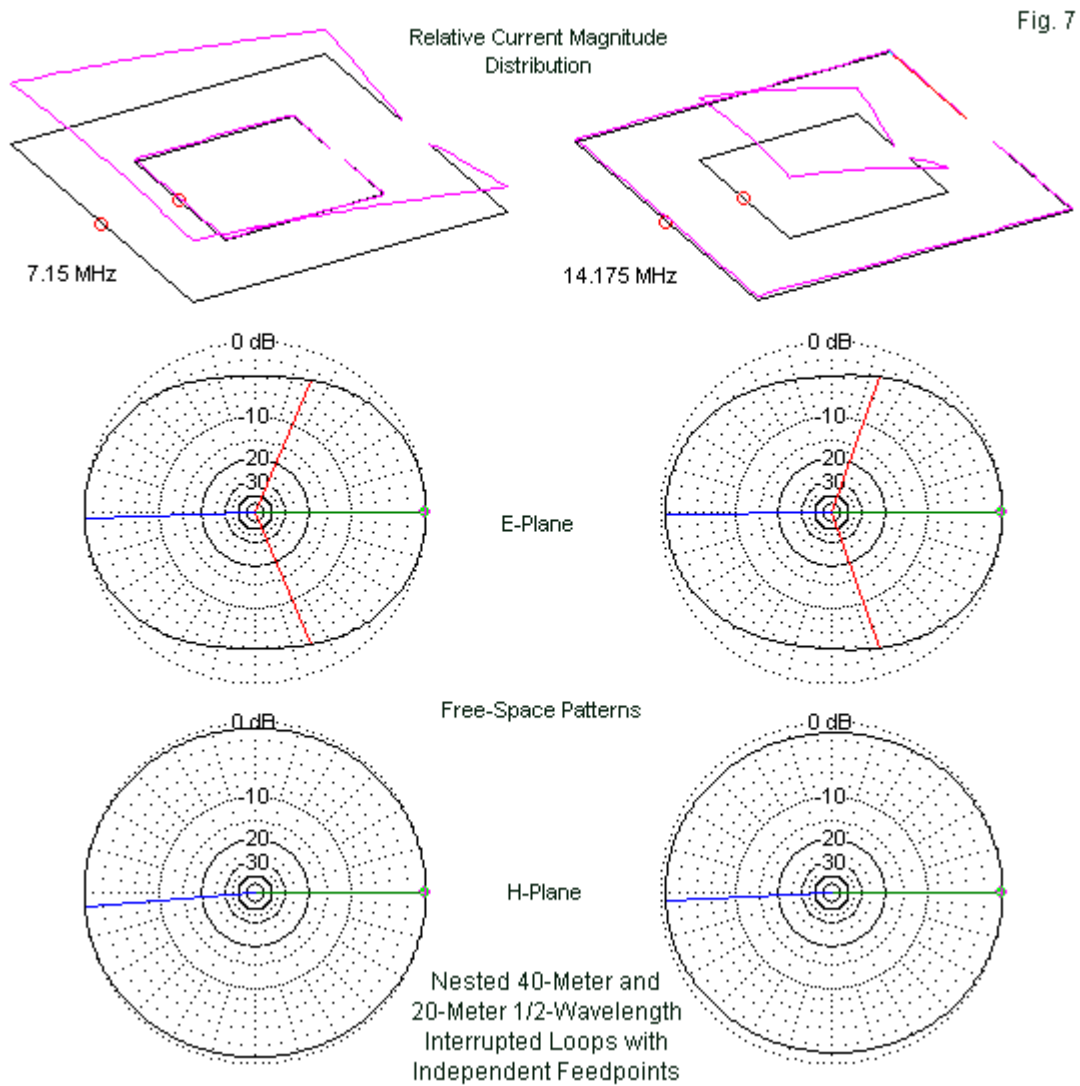

Fig. 7

Relative Current Magnitude Distribution

7.15 MHz

14.175 MHz

E-Plane

Free-Space Patterns

H-Plane

Nested 40-Meter and 20-Meter 1/2-Wavelength Interrupted Loops with Independent Feedpoints

We may start—from a design and modeling perspective—by nesting two loops to look for unwanted interactions between them. For simplicity, let's make loops that are self-resonant

independently at 7.15 and 14.175 MHz. When we combine the loops concentrically but preserve the independence of the feedpoints, we discover that even a 2:1 frequency ratio is insufficient to prevent interactions. However, the interactions are far from fatal, for the off-band loop remains relatively inert with respect to radiation. **Fig. 7** provides the loop outlines and the relative current magnitude curves along the elements, along with E-plane and H-plane free-space patterns. **Table 2** supplies the numerical data to accompany the figure.

Table 2. Independent nested interrupted loops for 40 and 20 meters

Band/ Frequency	Side Length feet	Gap feet	Gain dBi	Beamwidth degrees	Impedance R+/- jX Ω
40 m/7.15 MHz	18.0	2.66	0.79	133	12.3 + j1.7
20 m/14.175 MHz	9.08	1.34	1.09	141	9.4 – j1.4

The basic interaction between loops shows up most clearly in the 20-meter data and patterns. The E-plane patterns is slightly asymmetrical, but not seriously so. As well, the resistive component of the feedpoint impedance on 20 meters is lower than the value for an isolated or monoband version of the antenna. Nested inner loops also show a slight increase in the gain difference along the main axis. However, the value never rises to a significant level in the most common nesting configurations. These notes do not record the small front-to-back values that appear in the models.

Before we contemplate making any loop dimensional adjustments, let's also look at the question of using a common feedpoint for the nest of loops. **Fig. 8** shows the three main methods for feeding the pair of loops. We have already examined the use of separate feedlines. Both of the other methods employ a 50-Ω transmission line between the two loops. The difference between the two systems with a common feedpoint is the location. The center system places the feedline on the 40-meter element, while the right hand system places the feedpoint on the 20-meter element. **Table 3** provides the data to show us any difference between the two feedpoint locations. It also includes the anticipated difference in values if we select different velocity factors for the lines. The table shows values for the two most common velocity factor values: 0.80 and 0.67. The absence of very significant differences between the performance values that result from changing the velocity factor of the line show that the value is not critical to success.
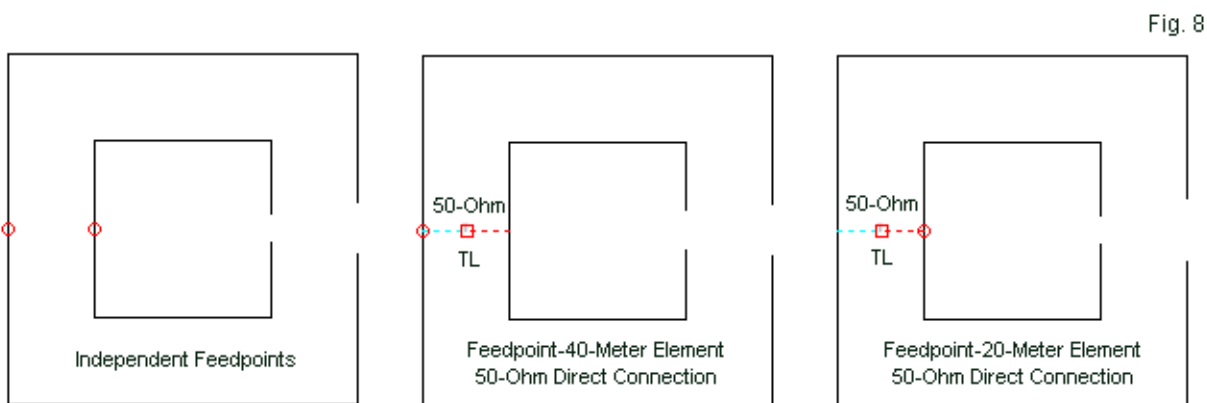
Fig. 8

Independent Feedpoints

50-Ohm
TL
Feedpoint-40-Meter Element
50-Ohm Direct Connection

50-Ohm
TL
Feedpoint-20-Meter Element
50-Ohm Direct Connection

Alternative Methods of Feeding Nested 1/2-Wavelength Interrupted Loops for 40 and 20 Meters

Table 3. Performance of nested interrupted loops for 40 and 20 meters using a common feedpoint and 50-Ω connecting lines with different velocity factors.

Band/Frequency	Side Length feet	Gap feet	Gain dBi	Beamwidth degrees	Impedance R+/- jX Ω
1. 40-meter element feedpoint					
a. Velocity factor: 0.8					
40 m/7.15 MHz	18.0	2.66	0.78	134	13.6 + j0.8
20 m/14.175 MHz	9.08	1.90	1.09	141	9.4 – j1.4
b. Velocity factor: 0.67					
40 m/7.15 MHz	18.0	2.66	0.78	134	13.6 + j0.6
20 m/14.175 MHz	9.08	1.90	1.09	141	8.5 + j5.1
2. 20-meter element feedpoint					
a. Velocity factor: 0.8					
40 m/7.15 MHz	18.0	3.20	0.80	131	12.6 + j0.2
20 m/14.175 MHz	9.08	1.30	0.97	140	11.0 – j1.0
b. Velocity factor: 0.67					
40 m/7.15 MHz	18.0	3.20	0.80	131	12.7 + j2.7
20 m/14.175 MHz	9.08	1.30	0.96	140	11.0 – j1.3

In all cases, I have left the outside dimensions of both loops the same as for the independent loops. I adjusted the loop gap for both elements to achieve resonance using the connecting cable with a 0.8 velocity factor. I then checked the performance using a new velocity factor without changing the dimensions. As the table shows, the performance does not change in any way that exceeds the normal construction variables that attend to any antenna of this type.
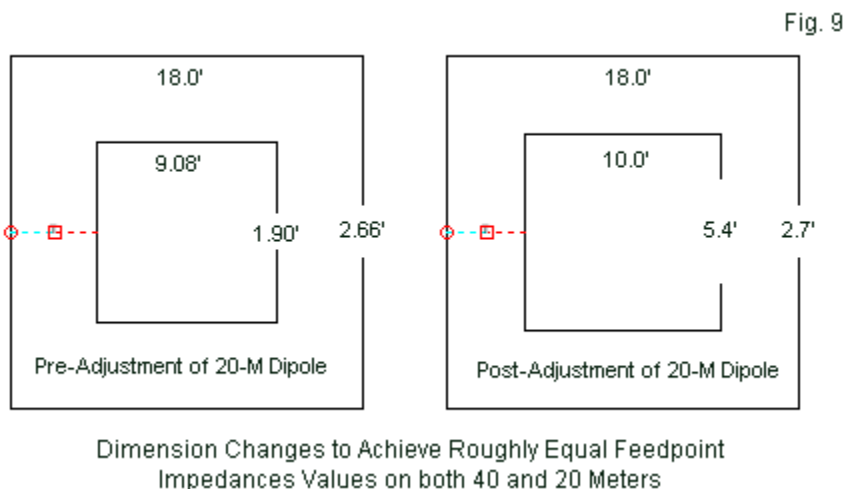
For the 40-20-meter combination, the 20-meter feedpoint proves superior in the sense of yielding feedpoint resistance values that are within tolerances. Let's assume the use of a 1:4 transformer, of either conventional or transmission-line construction. Since the desired impedance at the main cable junction is about 50 Ω, an antenna impedance of about 11 Ω to 14.5 Ω is likely to yield the best performance, since with a 4:1 ratio of transformation, we would obtain a resistive component of 44 Ω to 58 Ω at the design frequency. On both bands, the 20-meter feedpoint position supplies values within the desired limits. With a 40-meter position for the junction of the main feedline and the connecting line, the 20-meter resistive component falls below the desired level.

Now let's suppose that we wish to use the 40-meter feedpoint position. Since the largest loop in the set already meets the impedance limits that we set, only the inner 20-meter element requires adjustment. Since we are dealing with mutilated dipoles and not true loops, there is no magic to the initial proportions of the 20-meter element, which was simply a scaled version of the 40-meter element. We may enlarge the square and raise the resistive impedance component, adjusting the gap distance to re-establish resonance.

The process of altering the dimensions of the 20-meter loop does interact with the 40-meter element, but not beyond the limits of adjustment by changing the 40-meter gap alone. As shown in **Table 4**, the 20-meter loop has entirely new side and gap dimensions to bring its impedance values within range when using a 40-meter feedpoint. **Fig. 9** shows the revised outline of the nested loops. Note that the basic performance of the two elements does not change except for the better coincidence of the two feedpoint impedance values.

Table 4. Performance of nested interrupted loops for 40 and 20 meters using a common 40-meter-element feedpoint and 50-Ω connecting lines with different velocity factors.

Band/ Frequency	Side Length feet	Gap feet	Gain dBi	Beamwidth degrees	Impedance R+/- jX Ω
a. Velocity factor: 0.8					
40 m/7.15 MHz	18.0	2.70	0.78	134	13.6 + j0.4
20 m/14.175 MHz	10.0	5.40	1.10	124	12.1 – j0.8
b. Velocity factor: 0.67					
40 m/7.15 MHz	18.0	2.66	0.78	134	13.6 + j0.6
20 m/14.175 MHz	10.0	5.40	1.09	127	12.3 + j3.9

Fig. 9

Dimension Changes to Achieve Roughly Equal Feedpoint
Impedances Values on both 40 and 20 Meters

Nesting folded elements does nothing to improve the SWR bandwidth of the 40-20-meter combination array. **Fig. 10** provides sweeps across each band relative to the resonant impedances on each band. The 40-meter curve is almost identical to the curve for the monoband version of the antenna. The 20-meter curve handles more of that band with less than a 2:1 value, but only because 20-meters is a much smaller band. Nevertheless, the interrupted loop fails to cover more than about 55% of the entire band.
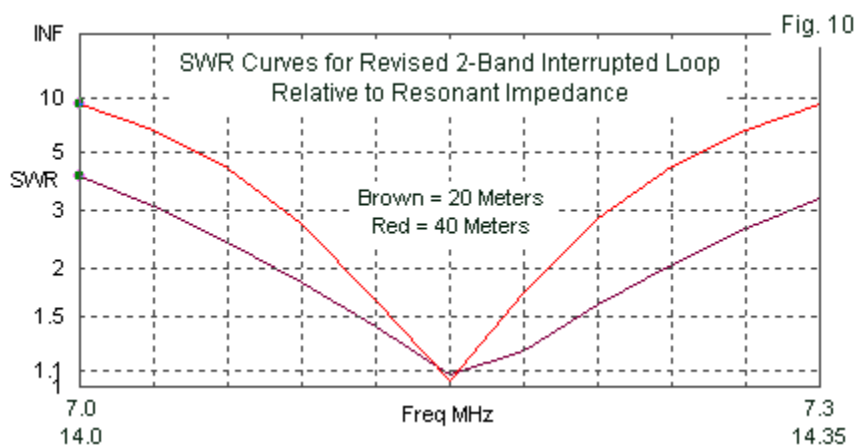
The 40-20-meter combination is not the only one possible. We should check a combination with a smaller frequency ratio to determine if we encounter any unwanted interactions. A 40-30-

meter combination might be well suited to this task. **Fig. 11** shows the outline of a modeled 40-30-meter loop nest that uses the 40-meter element as the main feedline junction. The side length of the 30-meter loop is simply the scaled value from the original 40-meter loop. Both loops required only a small adjustment to the gaps to arrive at satisfactory impedance values. **Table 5** provides the numerical information for this combination. Data for a velocity factor of 0.67 is omitted, since that factor is non-critical.
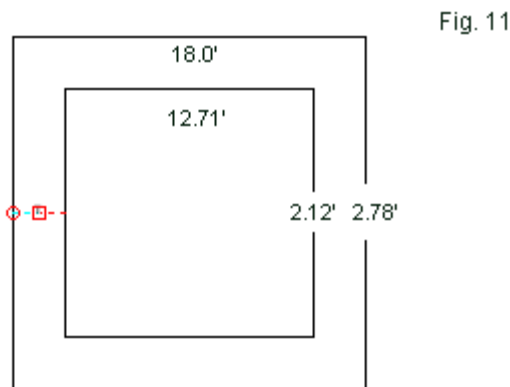
Free-Space Outline and Dimensions of a 40-30-Meter
Interrupted Loop with a 40-Meter Feedpoint

Table 5. Performance of nested interrupted loops for 40 and 30 meters using a common 40-meter-element feedpoint and 50-Ω connecting lines with different velocity factors.

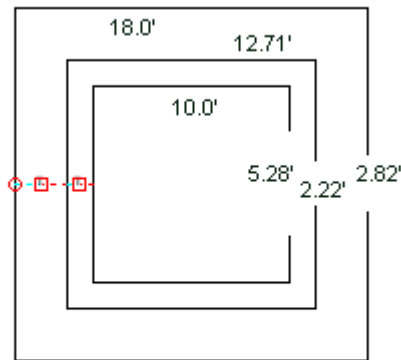| Band/ Frequency	Side Length feet	Gap feet	Gain dBi	Beamwidth degrees	Impedance R+/- jX Ω
a. Velocity factor: 0.8					
40 m/7.15 MHz	18.0	2.78	0.75	135	13.7 + j0.7
30 m/10.125 MHz	12.7	2.12	0.82	131	11.0 – j0.1

The exercise suggests that we may easily nest 2 interrupted loops (or folded-up dipoles) and use a single main feedline by connection to two loops with a short, direct length of 50-Ω cable. Depending on where we place the main feedline junction, we may have to alter the dimensions for the higher of the two bands, but we may easily do so, since the exact shape of the squares is not important, and the size of the inner squares does not affect the total area required by the nested set of antennas.

A Tri-Band Nest of ½-λ Interrupted Loops

The next step in the process of nesting involves adding a third loop to the pairs that we have been exploring. For each option, we must decide whether we wish to use the largest loop or the smallest loop as the location of the main feedline junction. Let's explore a 40-30-20-meter combination of loops using both options to see what we can do and what differences may exist between the feedpoint options.

Fig. 12 shows the outline of a tri-band nest that places the feedpoint on the 40-meter element. As usual, the connection to the other elements is a 50-Ω line with a velocity factor of 0.80. The line takes the shortest route from one element to the next. **Table 6** provides the associated numerical data.
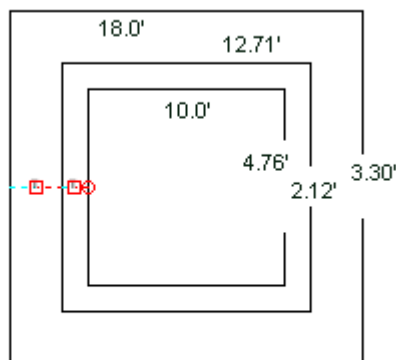
Fig. 12

18.0'
12.71'
10.0'
5.28' 2.82'
2.22'

Free-Space Outline and Dimensions of a 40-30-20-Meter
Interrupted Loop with a 40-Meter Feedpoint

Table 6. Performance of nested interrupted loops for 40, 30, and 20 meters using a common 40-meter-element feedpoint and 50-Ω connecting lines with different velocity factors.

Band/ Frequency	Side Length feet	Gap feet	Gain dBi	Beamwidth degrees	Impedance R+/- jX Ω
a. Velocity factor: 0.8					
40 m/7.15 MHz	18.0	2.82	0.74	137	14.4 + j0.7
30 m/10.125 MHz	12.7	2.22	0.71	134	11.2 + j0.6
20 m/14.175 MHz	10.0	5.28	1.03	124	11.7 + j0.8

If we move the feedpoint to the 20-meter or inner element (closer to the support mast), we obtain the outline shown in **Fig. 13**. Note that only the gap distance changes on each band. The side lengths remain the same as for the use of the 40-meter element as the main feedline junction point. The numerical data for the outline graphic appear in **Table 7**.

Fig. 13

18.0'
12.71'
10.0'
4.76' 3.30'
2.12'

Free-Space Outline and Dimensions of a 40-30-20-Meter
Interrupted Loop with a 20-Meter Feedpoint

Table 7. Performance of nested interrupted loops for 40, 30, and 20 meters using a common 20-meter-element feedpoint and 50-Ω connecting lines with different velocity factors.

Band/ Frequency	Side Length feet	Gap feet	Gain dBi	Beamwidth degrees	Impedance R+/- jX Ω
a. Velocity factor: 0.8					
40 m/7.15 MHz	18.0	3.30	0.76	133	13.2 – j0.2
30 m/10.125 MHz	12.7	2.12	0.67	134	11.5 – j1.0
20 m/14.175 MHz	10.0	4.76	0.95	130	15.4 – j0.4

The side length of the 20-meter loop might be reduced to about 9.9 down to 9.8 feet (with adjustments to the gap distance) to bring the impedance to a slightly lower level. However, within the confines of this free-space exercise, that move was not warranted. The reason for not perfecting the loop shapes to the *n*th degree has to do with the changes in performance that occur as a function of the height of the antenna above ground. These performance changes will dictate loop dimension adjustments considerably greater than slight departures from the prescribed impedance limits.

Let's return to the tri-band nest of loops that used the 40-meter element as the feedpoint junction position. We shall place the entire nest 50' above average ground, but we shall not change the dimensions from those shown in **Table 6**. We have two interests in this final exercise. One is to see how well the array performs in a more realistic scenario. I selected the 50' height because it is approximately ½-λ above ground at the middle frequency of the set. The 40-meter element is less than ½-λ above ground but high enough for reasonably good results. The 20-meter element, of course, is greater than ½-λ above ground and shows an appropriately lower TO angle. **Fig. 14** provides a set of modeled elevation and azimuth patterns for the nest at each design frequency. The patterns themselves would not change detectably had we used the 20-meter element for the main feedline junction. The numerical data from the exercise appear in **Table 8**.
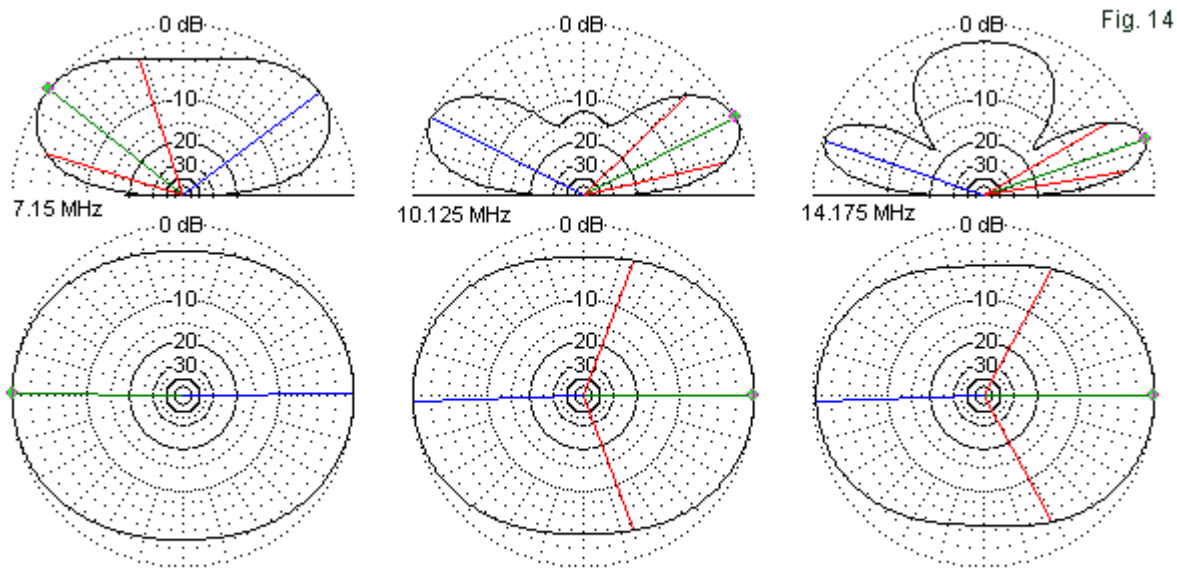
Nested 40-30-20-Meter Interrupted Loops with a 40-Meter Feedpoint
50' Above Average Ground: Elevation and Azimuth Patterns

Table 8. Performance of nested interrupted loops for 40, 30, and 20 meters using a common 40-meter-element feedpoint and 50-Ω connecting lines with different velocity factors with the nest 50' above average ground

Band/ Frequency	Gain dBi	TO angle degrees	Beamwidth degrees	Impedance R+/- jX Ω
40 m/7.15 MHz	4.84	37	---	16.2 + j0.1
30 m/10.125 MHz	5.82	27	140	10.7 – j0.2
20 m/14.175 MHz	6.32	19	123	11.6 + j1.7
Comparative AWG #12 copper linear dipole values				
40 m/7.15 MHz	6.19	38	98	86.6 – j6.0
30 m/10.125 MHz	7.52	27	85	66.8 – j8.4
20 m/14.175 MHz	7.41	19	81	72.7 + j7.4

Note: free-space impedance for all dipole: 73.0 Ω

The maximum gain values for the loop nest are systematically lower than the values for a linear dipole, shown in the table for comparison. The only significant difference is that a linear dipole shows a (numerically) marked decrease in gain as the height moves from about 5/8-λ through 7/8-λ above ground. The 20-meters height is about 0.7-λ. The nested loop on 20 meters shows the same phenomenon, but only as a decrease in the rate of gain improvement with added height.

For the two antenna types, the TO values are almost identical, since those values derive from the antenna height above ground. The two kinds of dipoles also show the same progression of beamwidth decreases, although the linear dipole begins with a much narrower beamwidth at 40 meters. The absence of an entry for the nested loop version at 40 meters indicates that there is less than 3-dB difference in gain along the axis of maximum gain and along a line at right angles to the maximum gain axis.

Relative to the free-space impedance values shown in other tables, the height of the nested loop set also shows significant variations. The progression is similar in type to the variations of the linear dipoles compared to their free-space values. Resonant dipoles show resistive values that vary with the height, but not in a simple manner. Rather, the values vary according to cyclical curves from about ¼-λ above ground to perhaps 1.25-λ above ground, above which the amount of variation is too small to consider significant. For the nested set of interrupted loops, a builder might wish to customize the dimensions of each loop after deciding upon the installation height above ground.

One construction facet that does not appear in the tables is the fact that the dimensions, especially the gap distance, can be somewhat critical. In other words, small changes in the gap can create considerable differences in the loop impedance. As we fold up a dipole, whether in a loop or in any number of other possible ways, the dimensions become increasingly sensitive to small changes, as witnessed by the shrinking SWR bandwidth of the antenna. A lossy impedance transformation device can mask this situation by providing a wider SWR bandwidth and less sensitivity to changes in the gap distance. However, the result antenna system (antenna plus matching device) will also show lower gain than the values in the tables. Since there are few balun devices designed expressly for the impedance range of 12.5 Ω to 50 Ω, a lossy impedance conversion device may be at work if a given nested interrupted loop antenna seems to provide relatively wide-band service for all loops in the nested collection. On the other side of the coin, setting the element gap distances for the desired portion of each band can be a daunting challenge for field adjustment, especially for bands well above the lowest frequency.

Conclusion

These notes have explored the territory of so-called interrupted ½-λ loops. In reality, these antennas, regardless of form, turn out to be complexly folded versions of the linear dipole. They exhibit low resonant feedpoint impedance values and reduced maximum bi-directional gain when folded to the minimum size for a square structure. However, their space-saving nature and the broader beamwidth, especially over ground at HF frequencies, has appeal to many amateurs with limited antenna installation area. With proper caution, they comprise a very useful class of antennas.

Some Interrupted Loop Shapes Used in Pursuit of Omnidirectional Coverage
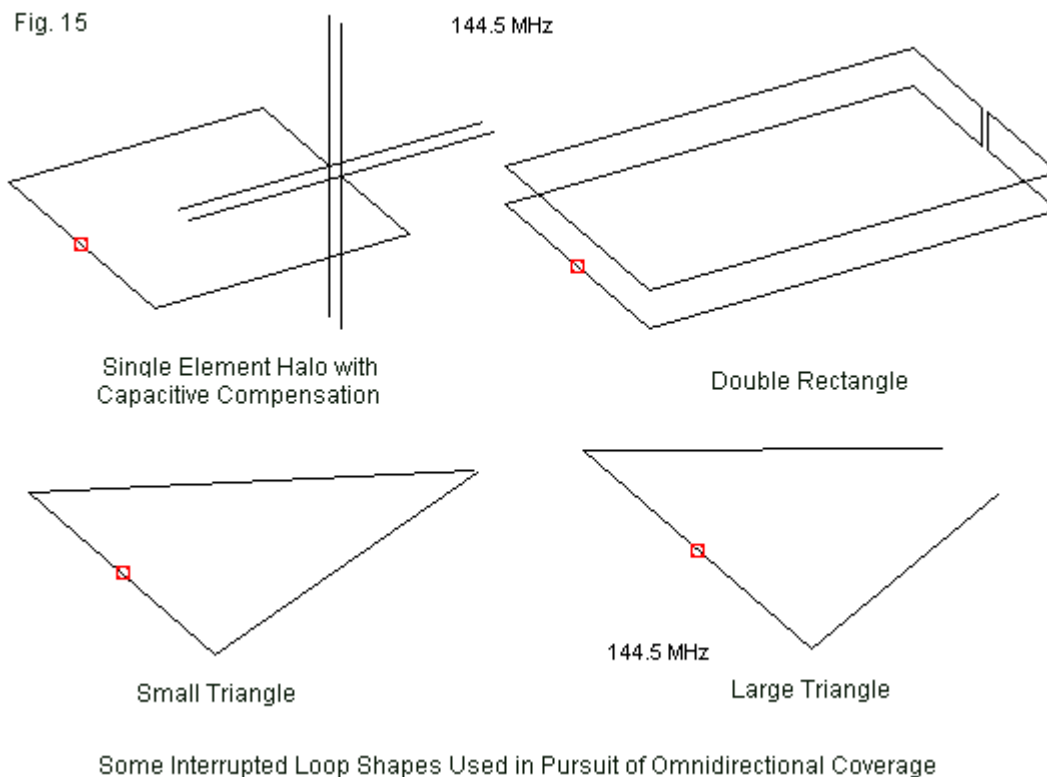
Since our efforts have focused on HF applications, we have by-passed a number of related dipole shape variations often used at VHF in an attempt to obtain a true omni-directional pattern with horizontal polarization. **Fig. 15** shows the outlines of some types. The halo model uses extended wires to obtain the required increase in capacitive coupling to yield a circular azimuth pattern, but actual antennas would tend to use solid discs that achieve the same coupling with a much smaller diameter.

Whether we call the configuration an interrupted loop ½-λ antenna or simply a folded-up (but not a folded) dipole, the arrangement has some significant uses at both HF and VHF frequencies. However, configuration also has equally significant limitations that any builder must deal with on the road to a successful antenna of this type.