# AERIAL PROJECTS

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# PREFACE

Although the popularity of building short wave receivers and other short wave equipment has waned somewhat in recent years with the rise in availability at low cost of high quality ready-made equipment, one exception has been the all-important piece of equipment that supplies the signal to the receiver; the aerial. Aerials and aerial accessories such as tuning units and preselectors remain very popular areas of experimentation, and are something that are of interest to those with commercially produced equipment as well as to the home-constructor.

The subject of aerials is a vast one, and in this book we will mainly consider practical aerial designs that give good performance, including active aerials, loop aerials, etc., rather than going deeply into the theory of aerials. A number of aerial projects including an aerial tuning unit, a preselector, and filters are also described, and this book is primarily intended for those who like to experiment with aerials and aerial equipment, or for beginners who need guidance in the choice, construction, and installation of a suitable aerial for use on the short wave bands.

*R. A. Penfold.*

## CONTENTS

# CHAPTER 1

# AERIALS

## Long-Wire Aerial

A long-wire aerial is just about the most simple type of aerial that can be used for serious DXing on the short wave bands, and in most situations it is possible to accommodate an aerial of this type. This is probably why the long-wire type of aerial has been so popular for many years and shows no signs of becoming any less popular now.

In theory a long-wire aerial is a straight length of wire at least a few wavelengths long. In practice this term is used for virtually any piece of wire used as an aerial, even though it will normally be far from straight and, except perhaps on the high frequency bands, is likely to be less than a couple of wavelengths in overall length. On the low frequency short wave bands a genuine long-wire aerial is not really practical since wavelengths of around 30 to 200 metres are involved, so that an aerial wire of around 60 to 400 metres would be needed on these bands, as a minimum requirement at that!

Modern receivers have quite high sensitivities in general, and in practice a long-wire aerial about 10 to 40 metres in length is likely to give good results. In fact quite a short aerial, say about 5 metres long, and mounted indoors either around a room or in the loft is likely to provide good reception of a large number of interesting stations. However, when propogation conditions are poor and signal strengths are low the added length of a proper outdoor long-wire aerial will give substantially better results. The difference in performance is likely to be most evident at low frequencies where a short aerial will be only a small fraction of a wavelength long and will consequently be grossly inefficient. If you intend to use an aerial of this type it is therefore best to use the longest piece of aerial wire you can accommodate.

Like any aerial, a long-wire type will give best results if it is mounted as high as possible, and preferably it should be sited where it is not obstructed by buildings or other very large structures or objects. Being realistic about it, it is unlikely that most radio enthusiasts will actually be able to mount the aerial on a couple of very tall aerial masts so that the wire is well clear of any obstructions. An important point to bear in mind if you do intend to employ tall aerial masts is that planning permission may be needed if the height of the masts (or mast) exceeds 10 feet above ground level. In such cases the advice of the local Council Surveyor should be sought, and if necessary planning permission should be obtained before installing the aerial supports (or support).

Many radio enthusiasts prefer not to bother with tall aerial masts, and use a relatively short aerial support or simply use any two convenient points as anchor points for the aerial wire. It is unlikely that this will give a very great reduction in performance when compared to the same length of wire mounted two or three times higher from the ground, although the reduction in performance will almost certainly be significant. Provided the aerial wire is reasonably long and a reasonable height from the ground (not much less than about 10 feet) good performance should still be obtained.

One or two points should be borne in mind when installing a long-wire aerial, and the simple installation illustrated in Figure 1 helps to demonstrate these points.

Firstly, it is essential to use suitable wire, and multistrand PVC insulated aerial wire can be obtained, or a fairly thick gauge (say about 14 to 20 swg) enamelled copper wire can be used. The insulation helps to weatherproof and protect the wire, and it also insulates it from the structure of the house at the point where it is taken into the house, which can be under a window for example. It is necessary to insulate the aerial from earth, or any earthed object such as a building, as some of the signal will otherwise leak away to earth and be wasted. This is the reason for using insulators at either end of the main section of the aerial rather than attaching the wire direct to the chimney stack and the post or tree. The two supporting lines are made from any strong man-made material (natural fibres may tend to rot) such as polypropolene twine. A pulley (which can be obtained from a chandlers or a hardware shop) is mounted at the top of the post (or on the tree) and the supporting line is

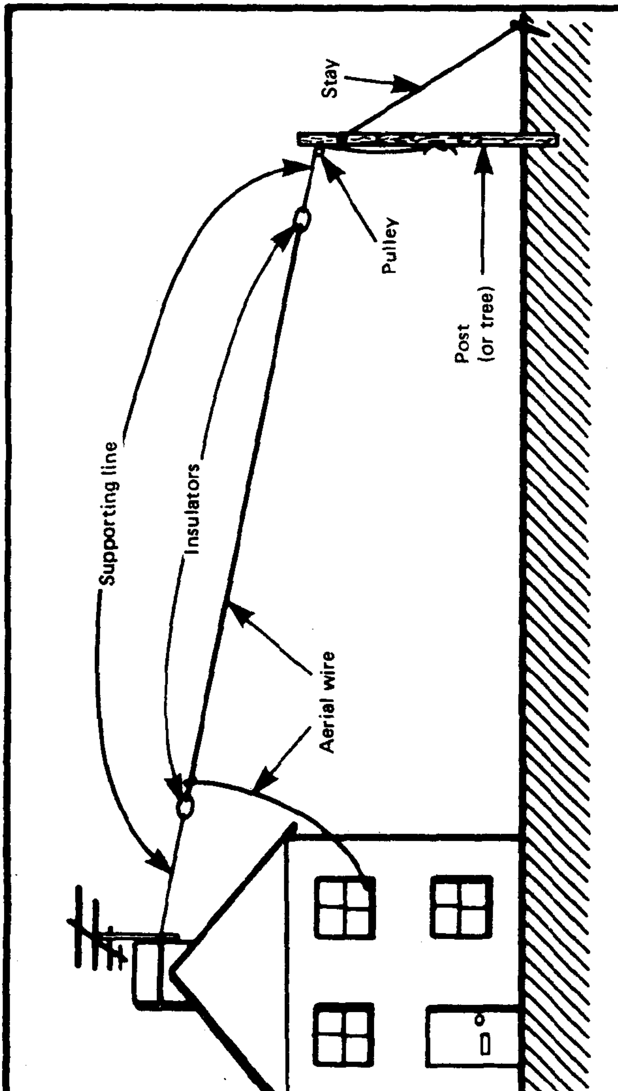


*Fig. 1. A simple long—wire aerial installation*

taken around this and tied-off at a convenient point lower down. This enables the aerial to be set at the desired tension, and it has to be accepted that there will be a significant amount of sag in the wire. Pulling the wire too tight will simply result in the wire snapping, either straight away or perhaps when the next high wind occurs. A certain amount of sag will not significantly affect the performance of the aerial, and neither will having one end of the aerial higher than the other.

A common problem is that of the aerial wire snapping due to the post or tree used to secure one end of the aerial moving

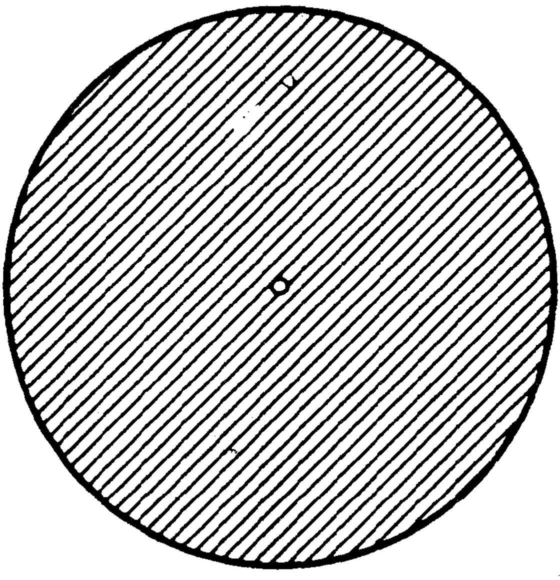

*Fig. 2. The polar diagram of an omnidirectional aerial such as a half wave vertical dipole*

about slightly in the wind. One way around this is to use a weight to keep the aerial under the desired amount of tension rather than securing the supporting line to the post, or a spring (of the torsion type) can be included in supporting line. Either method keeps a virtually constant tension in the aerial wire as the post or tree moves in the wind, but in practice these systems are not always fully effective and the wire can still break. This is normally caused by the supporting line becoming entangled with the pulley, or the two can become iced together in cold weather. The most reliable method in my experience is to simply leave sufficient slack in the wire!

Aerials have vertical polarisation if the aerial element or elements are mounted vertically, or horizontal polarisation if the element or elements are mounted horizontally. It is known as slant polarisation if the element or elements are between the vertical and horizontal positions. With DX signals the signals received are likely to have been transmitted with either horizontal or vertical polarisation, and propagation conditions can affect the type of polarisation of a signal. For optimum results the receiving aerial should have the same type of polarisation as the received signal, and the vertical lead-in section of the aerial can be useful when a vertically polarised signal is received. The lead-in should therefore not be thought of as a useless part of the aerial as far as signal pick-up is concerned, and a fairly long vertical lead-in section can be very advantageous under certain reception conditions.

## Directivity

Most aerials receive better in some directions than in others, and a long-wire aerial is not one of the exceptions. The normal way of showing the directional properties of an aerial is to use a polar diagram, and Figure 2 shows the polar diagram for an omnidirectional aerial such as a vertical half wave dipole (which will be considered in more detail later). The small circle at the centre represents the aerial, and the outer circle represents the relative efficiency of the aerial. Since the aerial has the same efficiency in every direction a simple circle is obtained, but in most cases a somewhat more complex polar response is produced with a consequent change in the diagram. For example, a half wave dipole when mounted horizontally has peak responses at right angles to the elements, and nulls in the directions in which the elements point. This gives a polar response having two nulls and two peaks, as shown in Figure 3.

The directivity of a long wire aerial changes with variations in frequency, but there is normally a lead-in which is at least partially vertical and this tends to reduce the directivity of the aerial. Because of these two factors long-wire aerials are normally considered to be omnidirectional, and although this is not strictly accurate, the slight directivity of a practical long-wire antenna is only of accademic importance.

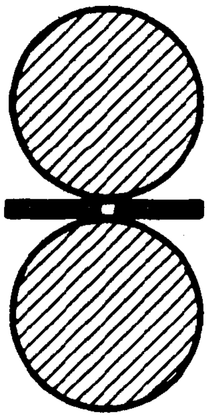

*Fig. 3. The polar response of a half wave dipole showing the two peaks and the two nulls*

## Half Wave Dipole

A half wave dipole has the advantage over a simple long-wire aerial of greater signal output, the directional properties mentioned above, and a consequent improvement in signal to noise ratio. It has the disadvantage of being somewhat more difficult to install (although it is nevertheless quite a simple type of aerial) and it will only give near optimum results over a restricted frequency span. In practice this means that a half wave dipole has to be designed for use on one amateur or broadcast band only. The basic arrangement of a half wave dipole is illustrated in Figure 4.

As can be seen from Figure 4, this type of aerial consists of a length of wire which is broken in the middle with the two sections feeding the receiver via a 75 ohm coaxial cable. The two dipole elements must not be joined electrically. The aerial is supported

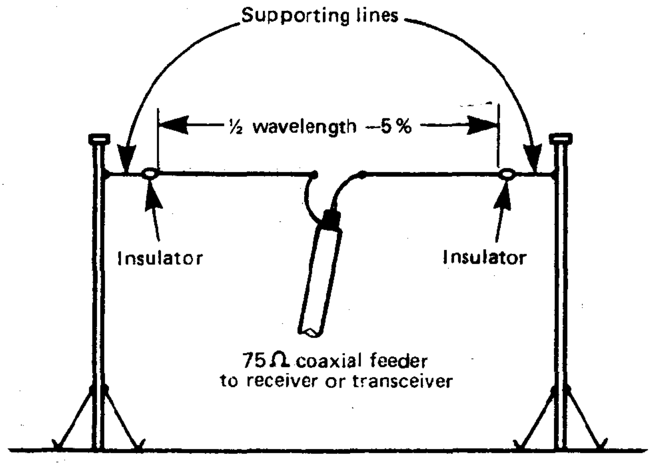


*Fig. 4. The basic arrangement of a half wave dipole antenna*

in the usual way using insulators, and lines made from an insulating material between the elements and the masts or other supports.

In practice you cannot simply join the two elements of the aerial to the feeder in the way shown in Figure 4 since the strain on the feeder would be so great that it would simply be ripped apart. A more satisfactory method is shown in Figure 5, but any method that prevents excessive strain on the feeder is

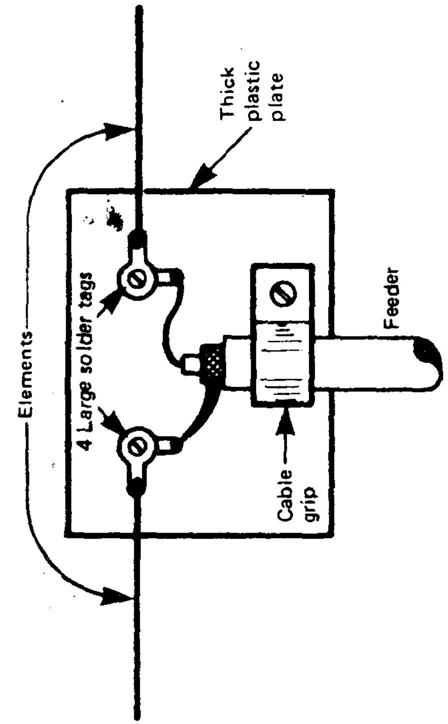


*Fig. 5. A simple method of joining the dipole elements to the coaxial feeder*

acceptable, provided the two dipole elements are not shorted together.

The precise length of the aerial is not exactly half a wavelength in practice as a number of factors alter the effective length of the aerial (its electrical and physical lengths are not the same). Assuming that the wire used for the aerial is a normal aerial type (such as 14 to 20swg enamelled copper wire) the total length of the aerial will need to be 5% less than half a wavelength, and each element will therefore be 5% less than a quarter wavelength.

If you are calculating the length of the aerial using frequency as the starting point, then the length in feet is equal to 468 divided by the frequency in megahertz. The length in metres is equal to 143 divided by the frequency in megahertz. Remember that this is the overall length of the aerial, and each element is only half the calculated length.

Of course, it is unlikely that you will require an aerial for use on just one frequency, and that it will be necessary for the aerial to operate over one amateur or broadcast band. The aerial is then designed to operate at the centre frequency of the band in question, and the amateur and broadcast bands are sufficiently narrow for good results to be obtained over the entire band.

The list given below shows suitable dipole element lengths for the amateur bands (including the three new bands). Note that these are the lengths for each dipole element and not the overall length of the aerial.

| | |
|---|---|
| 10 metres | 2.48 metres |
| 12 metres | 2.87 metres |
| 15 metres | 3.37 metres |
| 16.5 (17) metres | 3.95 metres |
| 20 metres | 5.04 metres |
| 29.5 (30) metres | 7.06 metres |
| 40 metres | 10.14 metres |
| 80 metres | 19.59 metres |
| 160 metres | 37.63 metres |

Dipoles for bands up to 40 metres can be accommodated in most back gardens without too much difficulty, but an 80 metre dipole obviously requires a fair amount of space and a 160 metre half wave dipole is around 75 metres (250 feet) in overall length.

The list shown below gives suitable dipole lengths (for each element again) for the broadcast bands, including the new 22 metre band.

| | |
|---|---|
| 11 metres | 2.76 metres |
| 13 metres | 3.30 metres |
| 16 metres | 4.03 metres |
| 19 metres | 4.66 metres |
| 22 metres | 5.22 metres |
| 25 metres | 6.03 metres |
| 31 metres | 7.37 metres |
| 41 metres | 9.93 metres |
| 49 metres | 11.77 metres |
| 60 metres | 14.58 metres |
| 75 metres | 17.99 metres |
| 90 metres | 21.67 metres |
| 120 metres | 29.80 metres |

Once again, most back gardens will accommodate a half wave dipole for the higher frequency bands, but for the 60, 75, 90 and 120 metre bands an aerial of this type will often be an impractical proposition.

**Inverted V Aerial**

This is really a modified version of the half wave dipole. This type of antenna is illustrated in Figure 6 and it should be obvious from this how the "inverted V" name is obtained.

The inverted V configuration has similar characteristics to a half wave dipole and has the obvious advantage of needing only one mast or other central support. Although at first sight it may appear to need less space than a half wave dipole this is not necessarily the case. The elements are slightly longer than for a half wave dipole, and in order to keep the elements well above ground level it is either necessary to have a tall aerial mast (especially for an aerial cut for a low frequency band) or keep the angle between the elements quite large and have very long supporting lines. This type of aerial is probably most suitable for use in situations where suitable supports for the aerial are already

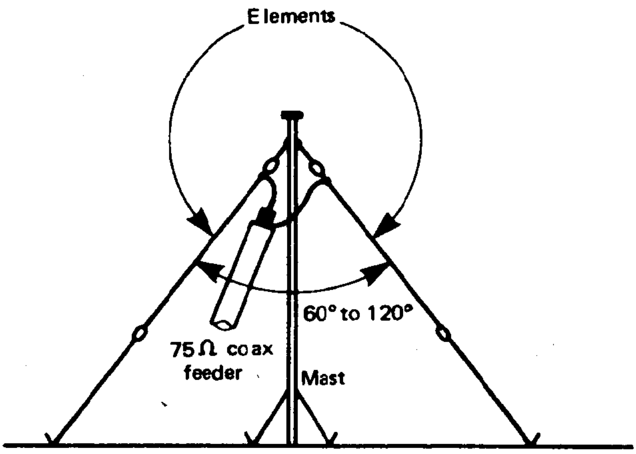


*Fig. 6. The arrangement used for an inverted "V" antenna*

available or are easily improvised. For example, aerials of this type are often installed over the pointed roof of a house (but must be kept reasonably well clear of the roof in order to obtain good results).

The length of an inverted V aerial in feet is equal to 486 divided by the frequency in megahertz, or in metres it is equal to 148 divided by the frequency in megahertz. This is the total length of the two elements, and must be halved to give the length of each element.

The lists provided below give the element lengths (not the overall lengths) for inverted V antennas for use on the short wave amateur and broadcast bands.

*Amateur Bands*

| | |
|---|---|
| 10 metres | 2.56 metres |
| 12 metres | 2.97 metres |