Antenna for reducing skywave interference

By Dr. O. G. Villard, Jr.

Introduction

This article describes a simple and compact means for converting standard book-size battery-powered shortwave receivers to directional reception. Such directivity can be used to reduce interference when the desired and the interfering signals are coming from different directions. The arrangement functions indoors as well as out, although better outdoors. Construction is straightforward and can be done with commonly available mechanical components. No modifications to the radio are required for installation. There is some loss in sensitivity, but the radio's normal tuning adjustments are unaffected. Remember that is impossible to be predict exact results, but then that is half the fun of antenna experimentation.

This report was originally prepared by O. G. Villard for Dr. Kim Elliott of the Voice of America's Office of Audience Relations. It is being made available by Radio Netherlands as a service to listeners, and a follow-up to a *Media Network* feature. SRI International does research and development only.

Purpose

The following has to do with an accessory for portable shortwave radios which can weaken interfering signals (either distant or local) with little effect on the desired broadcast. It can often restore program clarity and understandability when reception is degraded by troublesome co- or adjacent- channel interference. The essential arrangement consists of a turntable, a metal plate, and a replacement-type whip antenna.

Method of operation

The device makes reception poor in one or more directions although it remains nearly normal in most others. Radio and accessories are rotated on the turntable until the interfering signal is in a poor-reception direction. If interfering and desired stations are adequately separated in bearing, there should be only a small change in the strength of the desired signal.

Requirements

(1) Interference and desired signal must come from significantly different directions. Only one interfering signal can be nulled at a time, unless two or more such signals are coming from the same direction.

Father of OTH radar dies at 87

Oswald Garrison "Mike" Villard Jr., a professor emeritus of electrical engineering and electronics pioneer in radio and radar, died of pneumonia 7 January 2004 at a Palo Alto nursing home. He was 87.
One of Villard's biggest accomplishments was the development of over-the-horizon radar. His biggest hobby was ham radio.

(2) Radio must be compact and battery powered. External connections such as headphones, tape recorder, or power supply cable (whether in service or not) will cause poor performance and should not be used.

(3) The assembly must not be placed on - or immediately adjacent to - anything metallic. Suitable supports are wooden tables or cardboard boxes.

(4) For best results, the assembly should be spaced by 1 or 2 meters from wires or large metal objects. Except when changing stations, the listener's body should preferably be no closer than half a meter or so.

Features

(1) Easy construction - can be home-built.

(2) Compact in size - can be moved easily.

(3) Dimensions not critical.

(4) Little or no adjustments - except for antenna direction - required when changing stations or bands.

(5) Functions indoors although better outdoors.

Materials needed

(1) One kitchen turntable with tray made of wood or plastic, diameter equal to or larger than that of the receiver. (A wooden turntable with metal ballrace is fine.)

(2) One flat piece of any kind of metal, same size or somewhat smaller than the radio itself. Exact dimensions are not critical, but performance degrades if the plate size is greater than that of the radio.
(3) A standard replacement-type telescoping whip antenna. Maximum length should be somewhat longer than the radio's.

Assembly instructions

(1) The additional whip should be mounted vertically at one end of the (horizontal) metal plate. The plate's end can be bent upward to provide a support. The whip should be mounted in a position which makes it diagonally opposite the set's own whip, wherever that may happen to be.

(2) The radio is placed on the plate. Its weight and that of the plate itself will usually stabilize the whip. If the radio has a ground terminal, it should be connected to the plate. If not, connection can usually be made to the outside of sockets into which recorder jacks, etc., are plugged. If the ground connection is omitted, performance will be only slightly degraded.

(3) Plate and radio rest on the turntable and are rotated together.

Operating the antenna

(1) Select the desired channel in the normal way.

(2) Extend the radio's own whip to roughly its maximum length. Adjust the additional whip to be about 20% longer.

(3) Rotate the assembly (touching the plastic only; avoid the metal) until the interfering signal is weaker than the desired signal. There may be two positions where this is true; choose whichever position is most satisfactory.

(4) For the greatest interference reduction, adjust the length of the radio's whip with respect to the external whip, or vice versa. Best results are usually obtained when the external whip is appreciably longer than the radio's whip.

(5) If signals are very strong, it will help to shorten both whips in proportion. Automatic gain control action with otherwise smooth out signal strength changes due to antenna directivity.

(6) When a deep null is achieved, the position of the listener's body may affect its depth. This is particularly noticeable when the listener stands close to the antenna in the direction of the station. The effect is much less when the listener is so located that each whip is roughly equally distant from the center of his body. When the listener is half a meter or more from the whips, the effect of body capacity can normally be ignored.

(7) Shortwave signals of distant origin normally vary in strength with time at a comparatively slow rate.

This effect, called fading, can make finding nulls difficult. The easiest way to determine the true minimum strength direction(s) is to swing the turntable back and forth reasonably rapidly on either side of a suspected null position. The confusing effect of fading is then reduced because the natural signal-strength changes are usually slower than the rotation-caused ones.

Performance

(1) In the right circumstances, the arrangement can produce nulls having depths as much as 20 dB, which is usually adequate to separate interfering stations.

(2) There may be some variability in null depth with time, especially indoors. If the null fills in, a slight change in turntable position will usually restore its depth.

(3) Do not expect this simple device to indicate actual station directions accurately, especially indoors. It is designed to minimize one interfering signal at a time by directive action without consideration of signal bearing. However, it often does indicate *approximate* bearing, especially when an average is taken.

(4) Due to scatter propagation and/or ionospheric tilting, at any given time there will usually be some skywave interfering stations that cannot be significantly reduced in strength by compact directive antennas of any kind. However, the fraction of nearby or ground-wave interfering signals that can be reduced is much higher.

Troubleshooting

(1) Although poor directionality is often a result of propagation and/or transmitter beam heading, the problem can also be a local effect. If you suspect this, try moving the assembly to a new location. A wooden stool makes an excellent portable support. Unexpectedly poor results may sometimes be caused by concealed metal for example, wooden tables reinforced with a metal frame, metal mesh inside stucco walls, etc.

(2) Sometimes when a given station in a given direction can be nulled, other stations in the same band will be found to have nulls in the same direction no matter what the stations' true bearing. The result is that interference is then reduced by the same amount as the desired signal, just as if the source of the interference were in the same direction as the desired signal. This effect is typically encountered indoors and results from the presence of nearby metal conductors which reradiate strongly. It can usually be reduced by moving the assembly a few feet to a different indoor location. However, in extreme cases it may be necessary to move outdoors. The effect is worst in buildings of reinforced-concrete construction.

Two ways to verify normal operation

(1) With the direction of the assembly adjusted to null a given station, touching either whip should make the received signal sharply increase in amplitude, and by roughly the same amount.

(2) Remove the external whip and the supporting metal plate, leaving the receiver on the turntable with its whip in the normal vertical position. Rotating the turntable should now have little or no effect on signal strength. If there is a marked change, the radio is very likely in a region where there are too many nearby reflecting objects. Try moving to another location.

Possible substitutions

(1) The metal plate can be aluminum foil, if there is some other means for supporting the whip. (Foil and whip should definitely be connected, and foil and radio ground should also, if possible.)

(2) The `whip' can be any kind of conductor, although length adjustability is a great convenience. For example, it could consist of hookup wire supported by a wooden dowel.

(3) A turntable is quite desirable because of the ease with which it can be rotated. However, an acceptable substitute is a flat slippery surface which can be covered if needed with sheets of plastic or glossy magazine covers.

The radio and its whips could then be supported by a suitably-sized piece of wood or plastic.

(4) A whip that is too short can be extended by wrapping a length of bare copper wire around its upper end.

Operation outside the SW range

(1) The above arrangement works at all frequencies at which the radio receives through its whip. This is normally from 2 to 108 MHz. In the FM band, signals must be kept weak to prevent the limiter from smoothing out changes in amplitude. This can be done by detuning the receiver and/or retracting the whips until background noise becomes audible on the signal. Changes in noise level are then an indicator of signal strength.

(2) Adding an extra whip as above does not help in the MW broadcast band because virtually all radios receive in that band via built-in ferrite loops. However, the polar pattern of these loops also contains nulls much like those of the whips discussed above. These nulls can be used for interference reduction in the same general way. Even skywave interference can sometimes be reduced by tilting as well as rotating the radio. Supporting the radio in the reduced-interference position (which is usually not horizontal) can be a problem. Soft pillows have been used as adjustable supports for this purpose.

Modifications for possibly improved performance

The detailed behavior of the basic scheme described above depends on the set's location. When null depth is inadequate, the additions of a length of hookup wire (any size) attached to the end of the added whip by any convenient means - for example, standard small-size alligator clips. The wire behaves as an electrical extension of the added whip and modifies its behavior.

Note the small distance between the top of the radio's whip and the lowest part of the added wire. There is a best spacing between these two, which makes the null deepest and the off-null response greatest. The length of either whip can be adjusted for this purpose, and the adjustment is not critical. The K3MT version below shows a piece of metal, adjustable in position, which effectively adds capacity to the lower end of the radio's whip. It is convenient to use aluminum or metal foil attached to and held in place an inch or so above the top of the radio by a small clip. The clip permits the metal to be swung out of the way when changing stations. In many, but not all, situations, these additions have been found to improve null depth when used singly or both at a time. Of the two, the wire is the more helpful. Because of the variation in radio shapes, and the characteristics of typical locations, the improvement due to these devices cannot be guaranteed, but it may be well worthwhile.

This document is the latest in a series of articles describing different approaches to indoor directional reception at HF. The approach described herein is the simplest. Readers interested in the subject may wish to consult the following publications:

1. O. G. Villard, Jr., K. J. Harker and G. H. Hagn, "Interference-Reducing Receiving Antennas for Shortwave Broadcasts", Voice Of America Final Report on Project 1255, USIA Contract IA 22082-23, SRI International, Menlo Park, CA (January 1987) (NTIS #PB88-188180/GAR)

2. O. G. Villard, Jr., "Portable Unidirectional HF Aerial for Reducing Co-Channel Multihop Sky-Wave Interference", Proceedings of the Fourth International Conference on HF Radio Systems and Techniques, April 11-14 1988, pp. 141-144, Institution of Electrical Engineers, London, England (1988).

3. G. H. Hagn, O. G. Villard, Jr., C. A. Hagn, and M. J. Toia, "The Wide-Strip Horizontal Loop Antenna (HLA): An Effective Solution for Ground-Wave Interference to Shortwave Reception," Proceedings of the Fourth International Conference on HF Radio Systems and Techniques, April 11-14 1988, pp. 145-150, Institution of Electrical Engineers, London, England (1988).

4. O. G. Villard, Jr., "Interference-Reducing Antennas for Shortwave Broadcast Listeners", IEEE Transactions on Broadcasting, Vol. 34, pp. 159-166 (June 1988).

5. O. G. Villard, Jr., "The Coplanar-Twin-Loop Antenna", QST (American Radio Relay League magazine), Vol. 72, No. 9, pp. 29-35 (September 1988).

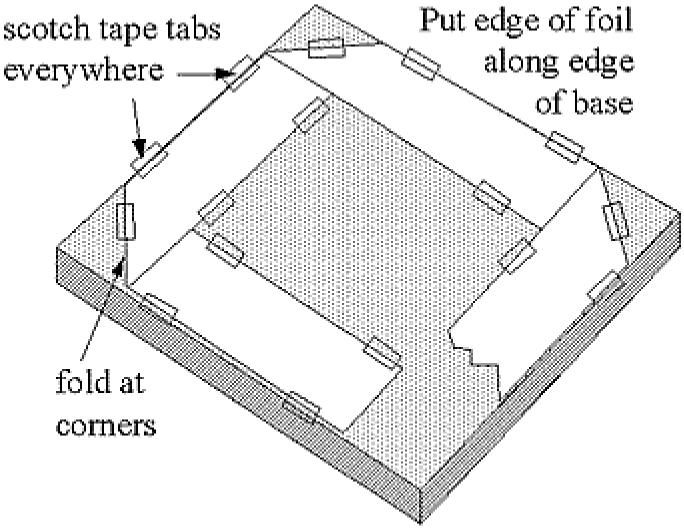
6. Villard, O. G. & R. Horvitz (editor), "Interference-Reducing Shortwave Antennas", ANARC Newsletter, Vol. 25, No. 1-2, pp. 14-20 (December 1989/ January 1990).

7. Villard, O. G. & R. Horvitz (editor), "Miniature Indoor Directional Antennas for Reducing Sky-Wave and Ground-Wave Interference in the Shortwave Bands", ANARC Newsletter, Vol. 26, No. 2-3, pp. 17-23 (February/ March 1990).

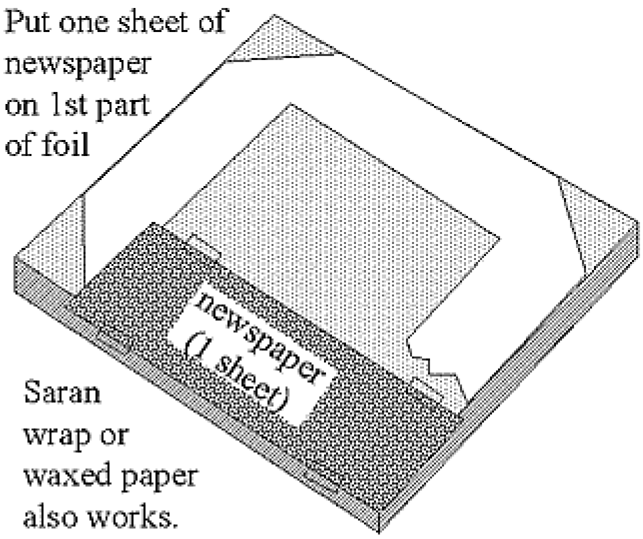
8. O. G. Villard, Jr., "Combatting Interference in Shortwave Reception with Compact, Indoor, Directive Antennas", World Radio & TV Handbook, 1990 Edition, (Andrew Sennitt, Editor), pp. 547-553 (January 1990).

The K3MT version

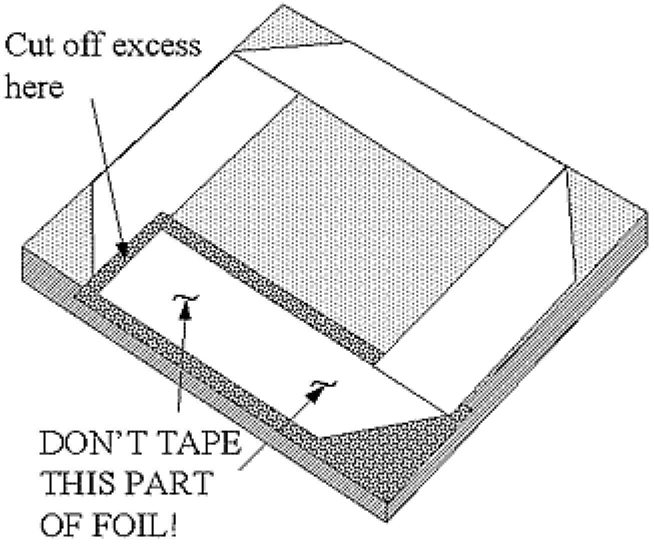
Get a 2' x 2' base - plywood, cardboard, stiff foam plastic, even the back of a wall-hung picture.



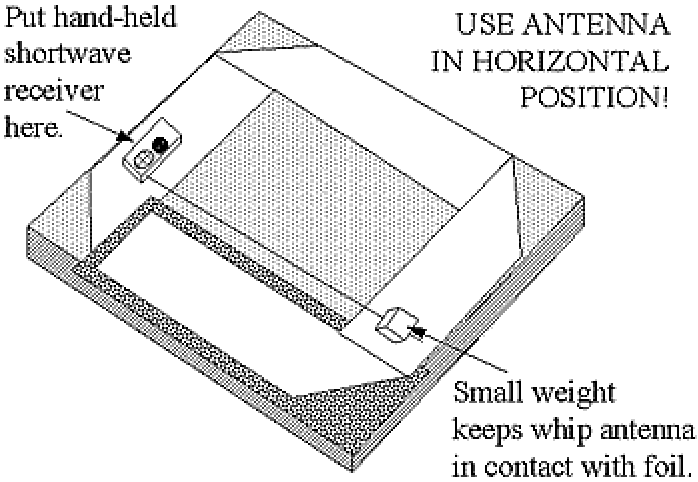
Cut a 6" wide piece of aluminum foil. Lay it on the base, withits edge along the edge of the base. Make a 6 1/2" gap in the corner where the foil begins. Then fold the foil over itself as shown above.



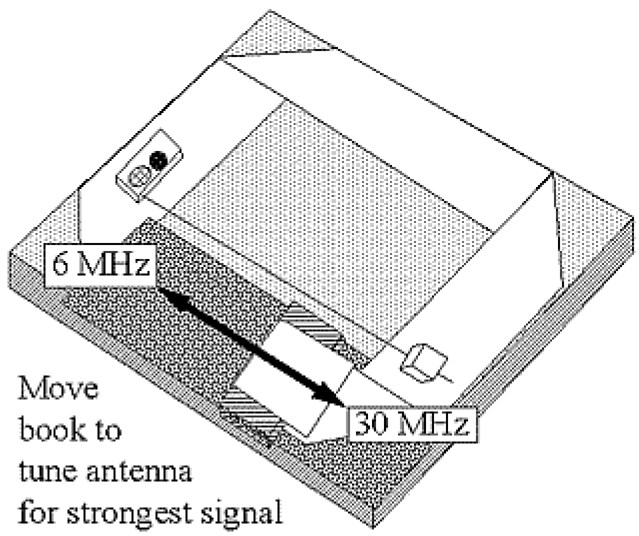
Cut a piece of newspaper 7" wide and 12" long -- or waxed paper, handkerchief, whatever -- and tape it over the first foil part.



Leave the fifth flap of foil loose, cut off excess foil.



Put the receiver on the foil as shown, don't worry about electrical connection. Pull the whip antenna out, use a small weight to make sure the whip contacts the foil.



Tune the antenna to the right frequency by sliding the book back and forth while keeping excess foil up and over the book. Further details at K3MT web.