# TELEVISION ANTENNAS and Their Installation


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**Why is it important to try television antennas in different positions? What is the effect on the image of multi-path signals? How should transmission lines be installed? How can Ghost Images be overcome?**



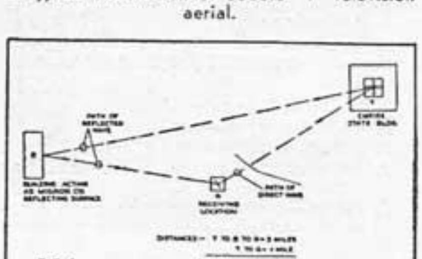
Top—Fig. 2, shows normal "test pattern." Lower photo—Fig. 3, shows "test pattern" marred by a reflected or multi-path signal.

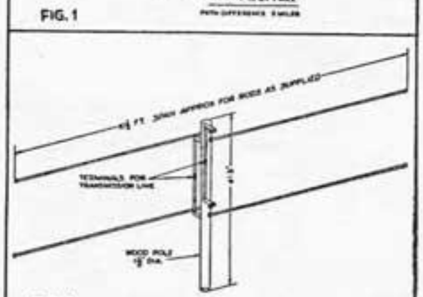
● IT has been said that radio receiver operation is as good as the antenna design and installation. This has been particularly acknowledged for satisfactory short-wave broadcast reception. Special types of antennas have been developed by the RCA Manufacturing Company, Inc., such as the "Magic Wave Antenna System," the "Spider Web Antenna," etc., designed for more efficient reception of short-wave transoceanic broadcast signals. Generally speaking, the design problem in any short-wave antenna system has been to increase the signal picked up and at the same time reject or reduce local noise so that the overall signal-to-noise ratio is sufficiently great to provide more satisfactory reception. The results obtained, to a great degree, depended on the installation. For instance, in general, the greater the height the Spider Web Antenna was installed the greater was the signal picked up and the less was the noise received. If *auto ignition* was the disturbing interference, its effect could be reduced by:

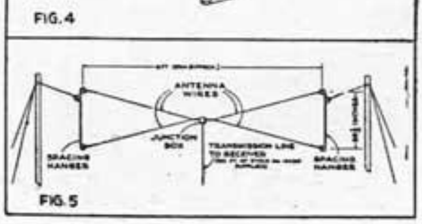
1. Installing the antenna as far as possible from the offending highway, and

2. Positioning the antenna so advantage could be taken of the null reception plane whenever possible.

Fig. I—Difference between direct and reflected transmission paths. Fig. 4—The new RCA Double Di-pole television antenna. Fig. 5—Typical installation of double "V" television aerial.




### Multi-Path Reception

In television reception similar problems of improving the signal-to-noise ratio in weak signal areas may require attention *and in addition* a new problem in reception appears particularly in congested city areas such as New York City. This problem is the phenomenon of *reflection*, or *multi-path* reception, that occurs in the ultra high frequency spectrum necessarily used for high definition television.

The ultra high frequency waves have what is called "quasi-optical" characteristics in their propagation. In other words, they are very similar to light waves in that they travel in a straight line and do not, for the most part, follow the curvature of the earth's surface. Due to this characteristic, the television transmitting antenna is installed at as high a point as possible near the center of an area to be covered by a television service. The transmitting antenna may be compared to a lighthouse which is either built as high as possible or located on a hill so the distance to the horizon is as great as possible. The National Broadcasting Company's television transmitting antenna located on the top of the Empire State Building permits sufficient height to give a horizon distance averaging about 40 miles. Under ideal conditions of the intervening earth's surface, local noise conditions, antenna type and height above sea level, etc., the reception range may be extended. Since the ultra high frequency waves behave similarly to light, they are subject to similar reflections, diffractions, etc., in their travel. For instance, a building surface may act as a mirror to reflect a transmitted wave back to a receiving location which is also picking up a direct wave. Many buildings may cause multi-path reception to occur at the receiver, resulting in the wanted picture being impaired by extra images or "ghosts."

The ultra high frequency waves used in American television transmission are *horizontally* polarized as it has been found that horizontally polarized receiving antennas (antennas having the pick-up rods or wires designed so they may be installed in a horizontal position or symmetrical to a horizontal plane) pick up less noise interference. Furthermore, a horizontally polarized antenna of the di-pole variety picks up practically no signal from the direction to which the free ends of antenna point. This directional characteristic is of assistance in reducing the effect of the reflection phenomenon previously mentioned.

A better understanding of the multi-path or reflection phenomenon can be had if Fig. 1 is studied.

Radio wave propagation velocity is 186,000 miles per second; therefore, a radio wave in traversing one mile requires 1/186,000 of a second. For two miles 2/186,000 or 1/93,000 of a second is required. On a 12-inch Kinescope the electron beam requires approximately 1/15,000 of a second to travel the full horizontal screen of about 10 inches. To travel one inch requires 1/150,000 of a second. As a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# Television Antennas

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matter of interest, the horizontal scanning speed of the electron beam in this particular case is about 8,500 miles per hour in traveling from left to right. In the illustration of Fig. 1, the reflected wave is delayed a difference of 1/93,000 second from the direct wave because its transmission path is two miles longer. It should be apparent then that the reflected signal will cause a second image displaced 93,000/150,000 of an inch, or about ⅝-inch to the right of the primary or wanted image.

New York City. This particular illustration is an unretouched photograph of an image obtained from a signal that contained no reflections or "ghosts" due to multipath reception.

Figure 3, on the other hand, shows the same test pattern seriously impaired by a reflected signal. Needless to say, a televised program would be likewise impaired and would be unsatisfactory to the owner of a television receiver. Reflections of much less intensity and negligible delay to be

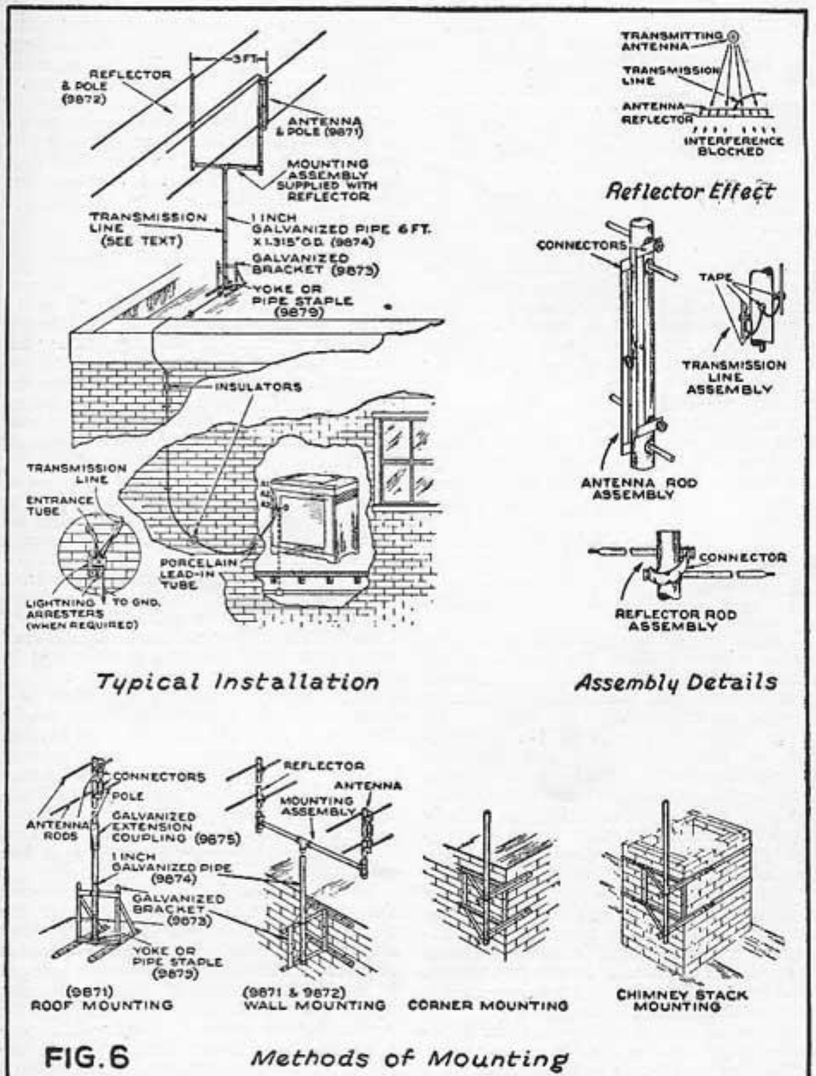


Fig. 6. Typical installation details of RCA Double Di-pole reflector antennas.

The reflected signal image may be white or black, depending on its polarity. Its intensity may vary from almost as intense as the primary image to a point where it is just noticeable. Any difference in relative intensities is due to the attenuation the reflected waves may encounter in their transmission path.

### Ghost Images

In Fig. 2 is shown the test pattern which the National Broadcasting Company transmits at periodic intervals from its transmitter W2XBS, Empire State Building,

hardly noticeable in themselves will cause the wanted image to appear fuzzy with consequent loss of observable detail of the finer portions of the received picture.

If the receiving antenna of Fig. 1 could be designed to reduce pick-up of the reflected wave signal, or signals, then the impairing of the received image may often be reduced or entirely eliminated.

Engineers studied the problem as based on seven years of RCA-NBC field test experience of *television reception* in the New York City area. Development work

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indicated that the ordinary di-pole could be made more directive by the addition of a parasitic *reflector* spaced about ¼ to 1/10 wavelength behind the antenna proper. This materially reduced pick-up from the direction opposite to the transmitter location. However, this occurred at a sacrifice in frequency response. It must be remembered that a television channel for high definition television occupies 6 mc. of which over 4 mc. is necessary for the picture modulation. Even the ordinary di-pole alone was found to have insufficient frequency response, particularly for the contemplated use of the television spectrum. It was early recognized that in suburban areas reflection phenomena were not usually present so little need for a di-pole reflector assembly would be expected.

### Double Di-pole Television Antenna

The outcome of the development was the design of the Double Di-pole Television Antenna, which could also be used as part of a special di-pole-reflector assembly. The Double Di-pole Television Antenna Assembly is shown in Fig. 4. The double di-poles used improve the frequency response to cover the contemplated use of the television spectrum. This antenna is recommended for suburban locations or any location where reflection phenomena are not present. Its sturdy construction and corrosive protection of its metal parts provide added safety when installed in high locations. The use of a round pole for support readily adapts the assembly for rotating the antenna so it will be broadside to the transmitter location for maximum signal pick-up. A compromise from the broadside position may at times be necessary so advantage of the null plane of reception can be taken to minimize local interference.

*Double "V" Wire Antenna:* A similar antenna of lower cost and requiring two supports, is available as the Double "V" Wire Television Antenna illustrated in Fig. 5.

For more efficient operation on the higher television bands the lengths of the antenna rods or wires should be changed in accordance with the instructions accompanying the antennas.

For congested city areas the combination of Double Di-pole and Reflector is recommended. Multi-path reception (causing "ghost" images) due to *reflections* can often be reduced materially or entirely eliminated with such an antenna installation. Reflections coming from such a direction as to form a broad angle with respect to the direction of the direct wave will usually be attenuated due to this antenna having a comparatively narrow zone of reception. The directional feature is obtained at negligible sacrifice of frequency response band and is a function of its unique design. The installation of the Double Di-pole and Reflector, as well as the use of other accessories are shown in Fig. 6.

The Double Di-pole and Reflector, while reducing pick-up from the direction opposite to the transmitter also increases the signal pick-up from the transmitter. Compared to a simple di-pole, the gain in signal strength is about 1.5 times. Reception from the transmitter location to that from the opposite location is in the ratio of about 3 to 1. Where low signal strengths are liable to be received due to distance or shielding effects, the installation of the Double Di-pole and Reflector will give an improved signal-to-noise ratio that may be sufficient to obtain satisfactory results. In some locations, sufficient signal strength may be available to permit rotating the antenna from the normal *broadside* position so advantage of the antenna's directional characteristic can be taken to minimize any serious noise interference.

### Two New Types of Transmission Line

For maximum efficiency the RCA Television Antennas should be used with corresponding type Transmission Lines of which there are two types. The type 9882 (1000 ft. roll) is a special low-loss weatherproofed line having only 4 db. loss at 50 mc. per 100 feet. The standard weather-proofed line, No. 9881 (1000 ft. spool) has a loss of 8 db. at 50 mc. per 100 feet. Interior finish lines of the proper surge impedance are also available in brown and white colors. Use of improper lines may result in excessive loss or may lead to *line reflections*. Use of the RCA Television Antennas and Transmission Lines with balanced input receivers, such as the RCA Victor Television Receivers, provides reduction of noise picked up on the transmission line.

For transmission line runs excessively long, such as over 200 feet, or where the receiver is located in an area of weak field strength, the low-loss line, type 9882, is to be recommended. For the average residential installation, the standard line, type 9881, is suggested.

### Notes on Installing the Antenna

The primary requisite for the *antenna location* is to place it in a "line of sight," or as near a "line of sight" as possible and broadside position to the transmitting antenna. This usually means that the antenna should be placed near, or on, or above the roof of the residence or apartment house. The location on a suburban dwelling may usually be decided upon from the standpoint of roof accessibility, availability of support, and shortest possible transmission line run. Reflection phenomena are not often present in the suburbs, so it is not likely that the antenna location need be changed once it is decided upon.

Obviously, as the horizon distance from the transmitter is approached, many objects may intervene to destroy the "line of sight." Usually, the *higher* the antenna is erected under such conditions the greater will be the received signal. The actual received signal intensity under any conditions is a function of the receiving antenna height. The antenna should be placed as high as possible and as far removed from highways, hospitals, doctors' offices, etc., to reduce effects of auto ignition and diathermy interference. Such locating of the antenna may be offset by the added line losses and consideration must be given to the type line used.

In the congested city areas, the antenna should be installed permanently on the apartment or residence roof *only* after actually observing results on the television receiver. A temporary transmission line can be run between receiver and the antenna allowing sufficient slack to permit rotating or moving the antenna. Then with a portable telephone system connecting an observer at the receiver and an assistant on the roof at the proposed antenna location, the antenna can be positioned to give the most satisfactory results. *A shift of only a few feet in antenna position may effect a tremendous difference in picture reception.*

*The only positive check of television receiver operation is to use the test pattern signal from the television transmitter. Field strength and interference conditions will be different at every location. Even though the antenna and receiver installation might be tested with a local R-F oscillator, there is no assurance that the antenna and receiver location will be satisfactory until the received test pattern is actually observed on the receiver's Kinescope.*

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In mounting any antenna, care must be taken to keep the antenna rods or pick-up wires at least ¼ wave length (at least 6 feet) away from other antennas, metal objects; such as, metal roofs and gutters, etc. Local fire regulations may require a certain distance between antenna and roof.

Under certain unusual conditions, it may be possible to rotate or position the antenna so it receives the cleanest picture over a *reflected path*. If such is the case, the antenna should be so positioned. However, such a position may give variable result with the weather, as a wet surface has been known to have different reflecting characteristics than a dry surface.

In short, a television receiving antenna and its installation must conform to *much higher standards* than an antenna for reception of International Short Wave and Standard Broadcast signals because:

(1) Intervening obstacles have a pronounced shielding effect on the ultra high frequency waves producing low intensity signals. Severe trouble with multi-path reception may often be experienced, especially in congested city areas.

(2) The picture signal is comprised of a very wide band or range of frequencies, all of which must be received with good efficiency.

(3) It must be continually remembered that the discernment of the eye is much more critical than that of the ear. More than ever, it can be said—"*The finest television receiver built may be only as good as the antenna design and installation.*"

### Hints on Installing Transmission Lines

After the antenna and receiver locations have been decided upon, the residence or apartment should be carefully surveyed to determine the best method of running the transmission line. The most important consideration is to keep the run as short as possible consistent with other factors such as appearance and availability or accessibility of support.

The transmission line should be supported on outside runs every 8 to 12 feet. Telephone bridle rings are a convenient and inexpensive means of line support. Number 14 Rawl or similar plugs should be used for support of the rings when masonry is encountered. Clearing obstructions, such as rain gutters, may be readily done by using 6 inch or 12 inch screw-eye insulators. The line should be secured to avoid vibration. Slack in the line should be taken up wherever a turn is made by appropriate taping. Use of ½ inch loom will provide protection to the line where abrasion might occur.

Entrance to the receiver location in a suburban residence may be neatly made by passing the line through a porcelain tube installed in a basement window and running the line in the basement to a location below the receiver, where a small hole may be drilled in the floor with the owner's permission. In order to maintain proper impedance relations, the free ends of the transmission line should never be fanned apart. *At the conclusion of the line installation it should always be checked for continuity and short circuit.*

It is extremely important that a *good* GROUND connection be provided for the television receiver. This is necessary to protect the user in case of a primary to secondary breakdown of the high voltage transformer.