SATELLITE TV ANTENNA

Now that you've built the antenna, you have to set it up and aim it in the right direction. This month we'll show you everything you need to know to complete the project.

BY H. D. McCULLOUGH

Part 3 BEFORE INSTALLING the 8-Ball, you need to know where the satellites that you're interested in are located relative to where you live. That information is needed to position the antenna properly.

Positioning the antenna

Using the graphs in Figs. 23 and 24, and Table 2, you can determine the elevation and azimuth from any location to any satellite. To use the graphs, you must know your longitude and latitude, and the longitude of the satellite. Table 2 shows the positions of the satellites in the Clark belt.

After determining the look-angles (elevation and azimuth) to the satellite(s) desired, you must set the base pads for the necessary azimuth heading. Figure 25 shows how the pads are positioned, and Table 1 (p. 62, Sept. issue) gives the front-to-back and side-to-side dimensions. Pour concrete piers or pads 1 foot square and 2 feet deep (more in loose soil). Set 10-inch long, ½-inch anchor bolts to project 2-3 inches above the surface. (Note that the rear pads are spread farther apart than the front ones. The front pads are 5 feet, 8 inches apart; the rear ones from 7 feet, 4 inches to 8 feet, 2 inches.) Figure 26 shows how the antenna is anchored on the pads.

If you are primarily interested in receiving signals from one satellite, then face the antenna toward the azimuth heading of that "bird" and, for elevation look-angles of 30 degrees or less, tilt the antenna back from the vertical an amount equal to *half* the elevation look-angle of that satellite. The focal point (and the horn/LNA location) will be 6-feet high and directly in front of the dish. (Refer to Fig. 4-a in "How the 8-Ball Got Its Shape", P. 61 in the September issue)

For elevation look-angles greater than 30 degrees, tilt the antenna back 15 degrees *less than the look-angle*. (See Figs. 4-b and 4-c of "How the 8-Ball Got Its Shape" as mentioned above.) Figure 27 shows how the antenna's tilt angle can be checked using an inclinometer. The inclinometer is made using a protractor, string, and plumb-bob.

TABLE 2

Satellite	Location (Degrees West) Longitude
Comstar III	87
Westar III	91
Comstar II	95
Westar I	99
Anik I	104
Anik B	109
Anik III	114
Satcom II	119
Westar II	123.5
Comstar I	128
Satcom I	135

Once the reflector is positioned fairly close to the desired azimuth and elevation settings, find the satellite by pointing the feed horn directly toward the center of the dish, and then moving the horn up and down and side-to-side around the point where the focal point should be. The best focus (and best picture) will be about 15 feet from the center of the dish. That assumes that you have an LNA, receiver (down-converter), and TV set all properly connected. Place the TV set where you can see it while positioning the antenna feed horn.

If you want to receive more than one satellite, position the reflector midway between the azimuth headings and elevation look-angles of the two satellites that are farthest apart. Just be sure to be within 15 degrees of the bore-sight direction of the satellite you are primarily interested in.

See Fig. 28 for the focus-point locations for seven satellites. The heading

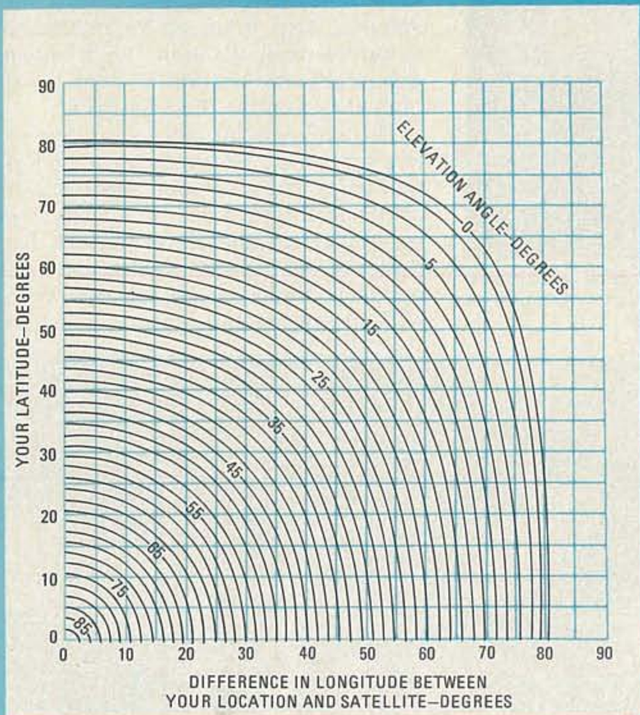

FIG. 23—ELEVATION ANGLE of the satellite can be determined easily by using this chart. Find the difference in longitude between the satellite and your location on one axis, and your location's latitude on the other. The point of intersection falls on a curve showing elevation angle.*

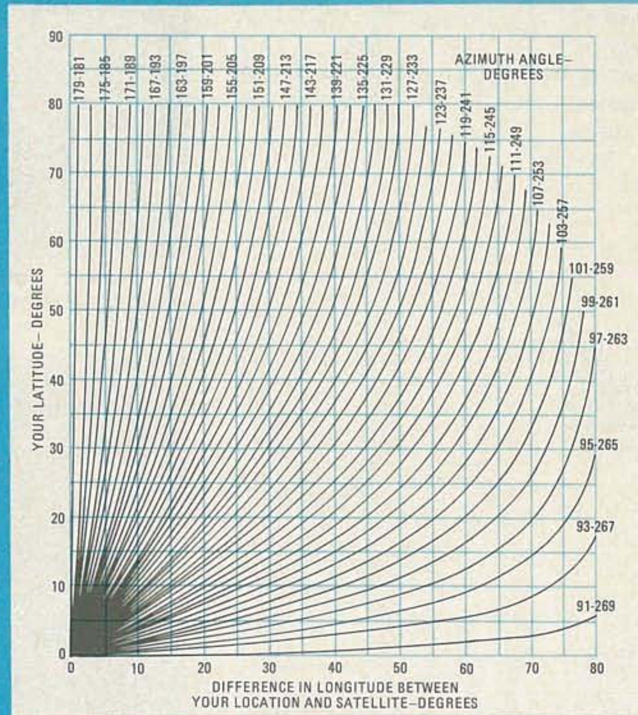

FIG. 24—AZIMUTH ANGLE is determined from this chart. The azimuth angles of 179 degrees and less are for satellites east of your location; angles of 181 degrees and up are for satellites west of you.*

(azimuth) given (220 degrees) is only accurate for one location—northern Arkansas—but the relative positions of the focus points (Fig. 28-a) will be the same anywhere.

The elevation look-angle will be largest for a satellite that is due south of your location. Notice that the greater the elevation angle, the lower the focus point will be for any specific angle you have tilted back the dish. The satellites used in the example in Fig. 28 are all west of due south and the most westerly satellite (Satcom 1) gives the highest focus point. Notice also that to receive all seven satellites with maximum efficiency, the dish has to be tilted back enough to accommodate the satellite with the highest look-angle (30-degree tilt in this example to match Anik I which has a look-angle of 45 degrees). That results in the focus point for Satcom I (the lowest look-angle) being rather high off the ground.

For that reason, and the fact that our experiments required moving the LNA/feed horn around, the test antenna was oriented more toward Satcom I, with signals still received with good efficiency from Comstar I, Westar II and Satcom II. The signals from the Anik were

*Figures 23 and 24 are reprinted through the courtesy of CATJ. They originally appeared in the November 1978 issue of that publication.

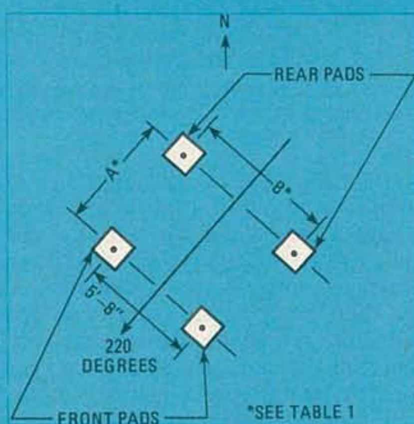

FIG. 25—MOUNTING PADS ARE POSITIONED according to the azimuth heading of the satellite you want. Here, the azimuth is 220 degrees, suitable for receiving satellites with azimuths from 205 to 235 degrees.

FIG. 26—CONCRETE BASE PADS support and anchor the four corners of the antenna. Anchor bolts and "J" clips secure the antenna to the pads.

FIG. 27—A SIMPLE INCLINOMETER (a protractor, string, and plumb-bob) used to check the tilt angle of the antenna. With the protractor against a vertical rib, read the angle where the string crosses the scale.

watchable, but not "clean." The problem of high off-the-ground focus points does not exist in the far Northern latitudes, where elevation look-angles are low for ALL satellites.

A feed horn is available from the supplier listed. If you decide to build your own, see Fig. 29 for the dimensions of the horn that gives the best results of all that we've tried. Ordinary galvanized sheet metal seems to work fine. Brass or silver may be better, but probably not much.

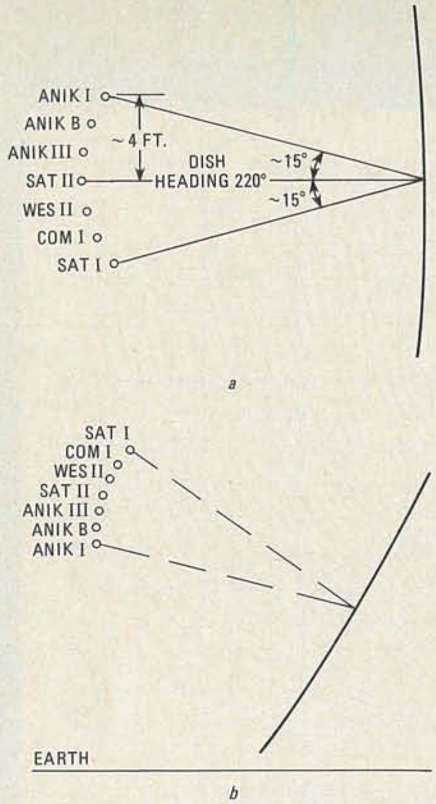

FIG. 28—HOW FOCUS POINTS ARE LOCATED: A top view of the antenna (*a*) shows the relative locations of the focus points for seven satellites. The side-view (*b*) shows the vertical position of the LNA horn for satellites.

FIG. 30—THE LNA/FEED-HORN ASSEMBLY can be mounted inside a length of PVC pipe as shown here.

A simple and inexpensive way to mount the LNA/feed horn is shown in Fig. 30. Attach the horn to the LNA and slip it inside a piece of 5-inch plastic pipe, 10 inches long. Secure it with any small brackets and spacers. Slip the 5-inch pipe inside a piece of 6-inch pipe, 12 inches long. Place soft spacers or pads between the pipes so that the inside pipe will rotate, but with enough friction to hold it in place. The assembly can be mounted on a board, with a motor attached to rotate the LNA for polarity selection.

Final alignment

After the antenna is in place on the base pads, you should adjust it for a precise curve. A simple way to do that is to tie a radius wire to a point 30 feet directly in front of the center of the dish, then check the antenna surface near each adjustment bolt and adjust so that every part of the dish is 30 feet from the radius point.

A radius wire with a spring-loaded end is best for this. The spring-loaded end is fairly easy to make. The prod is simply a piece of coat-hanger wire, about 15 inches long, with a loop at one end. The actual length of the prod is not critical as long as you remember that the total length of the radius wire and the prod should be approximately 30 feet. Slip a moderately-stiff spring over the hanger-wire prod and attach the spring and the radius wire to the loop as shown in Fig. 31. The spring makes it easier to hold a constant tension on the wire throughout the adjustment procedure; simply stretch the spring the same amount for each adjustment. A piece of tape can be stuck to the prod and used as a reference point as shown in Fig. 31.

To keep the spot where the radius point is tied from being too high off the ground, it may be necessary to tilt the antenna forward. If you do that, be sure to raise the two rear legs by the *exact* same amount so you don't warp the antenna. Also, if you tilt the antenna to a near-vertical position, tie it down temporarily to prevent it from being blown over during the adjustment.

The radius point can be located by trial and error. First attach one end of the radius wire to a point about 30 feet (the exact distance is not critical as long as it is close) directly in front of the center of the dish—or as near the center as you can tell by looking. Then with the spring end, check across the middle of the dish surface left to right to see if one side is closer to the radius point than the other. Move the radius point to the left or right as necessary to get the best "fit" across the dish. Repeat that procedure going from top to bottom, adjusting the radius point up or down for the best "fit."

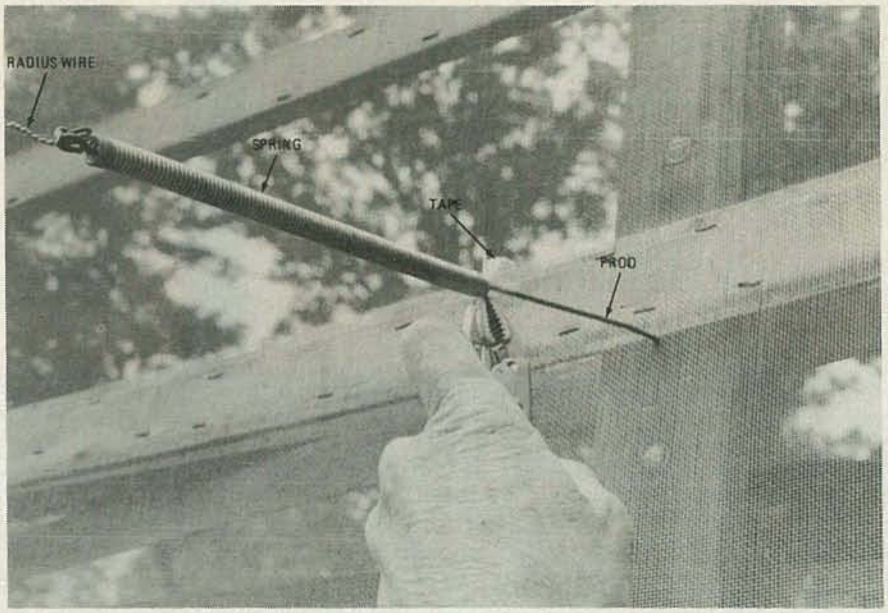

FIG. 31—RADIUS WIRE, 30 feet long, is used to check the reflector's curvature. Adjustment bolts are set so that all points on the surface are exactly the same distance from the radius point.

Once the radius point is set, move each adjustment bolt in or out where the bolt goes through the frame so that the prod on the end of the radius wire just touches the screen when the spring is stretched to where it just touches the piece of tape on the prod.

It is important to take your time and do this right. With two people, you should be able to set the surface to within 1/16-inch in 30 minutes or so. If you have the dish tilted forward when you complete the adjustments, carefully lower it back in place and sight across the edge of the dish to make sure there is no twist in the surface. If necessary, put a shim under a rear leg.

Probably the easiest way to get the reflector surface out of "true" and lose the effectiveness of the antenna is to

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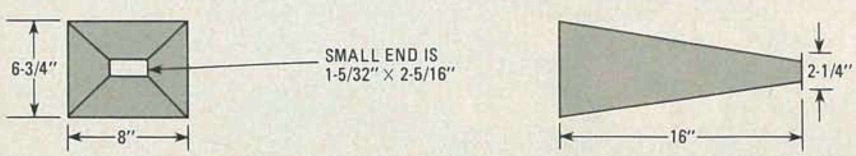

FIG. 29—FEED-HORN DIMENSIONS. Use these to build your own horn from sheet metal or a simlar material.

EQUIPMENT REPORTS

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tions varying between 1 millivolt and 1 volt—again depending on the range in use. Current (both AC and DC) can be measured on two ranges: 20 milliamps and 200 milliamps full-scale. Resolutions of 10 and 100 microvolts respectively are claimed. Resistance is measured over five ranges from 200 to 200,000 ohms full-scale with a maximum open-circuit voltage of 1.5 volts on the 200-ohm range and 0.65 volt on the others. The open-circuit voltage on the low-power resistance ranges is 0.4 volt, as previously mentioned. Resolution varies from 0.1 to 1000 ohms depending on the range in use.

The *model EZ-6100* requires two "AA"-size cells; their expected life is 300 hours. There is no provision for AC operation. While the instruction booklet does not contain a schematic, parts list, or troubleshooting hints, it does do a very good job of explaining how to use the meter.

In our tests we found that the unit was as accurate as the manufacturer claimed. In addition, we found it to be very handy to use, especially in the field. The *Model EZ 6100* sells for $142.00, about the same as many meters with fewer features. **R-E**

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FIG. 32—TWO STRINGS, installed after alignment as shown, make it easy to detect any warps in the reflector surface.

have one rear leg uneven with respect to the other. That causes a "twist" in the frame, and therefore, in the reflector surface. One way to check for a twist is to look at the antenna from the side and see if all the vertical ribs are parallel, or take an inclinometer and check each of the three middle vertical ribs. They should all have the same tilt angle.

Another, and perhaps the most accurate, way of making sure that the antenna retains its shape after it is aligned with the radius wire is to criss-cross a pair of strings as shown in Fig. 32. The strings must be installed after alignment, but *before* the antenna is moved. Install the strings from the top-right to the bottom-left corners, and from the top-left to the bottom-right corners. Adjust the strings as necessary so that they *just* touch at their centers. When you move the antenna, any twist will be apparent and can be quickly corrected by placing shims under one leg until the strings again just touch.

That wraps up our look at the 8-Ball. If you want a more complete picture on what satellite TV is all about, refer to the series of articles on this subject by Bob Cooper that appeared in previous issues of **Radio-Electronics.** If you would like to order a reprint of that series, see page 95. **R-E**

PARTS LIST—FEED HORN

Galvanized sheet metal
PVC pipe, 5-inch diameter, 10 inches long
PVC pipe, 6-inch diameter, 12 inches long.
Miscellaneous: Soft spacers or pads (see text), hardware, etc.

The following are available from McCullough Satellite Systems, PO Box 57, Highway 62-East, Salem, AR 72576: The 12-foot 8-Ball Satellite Television Antenna Kit, $750. Includes everything except staples and concrete for mounting base. Frame is 1½ × 1½-inch angle iron with all pieces cut to fit and drilled. One coat of primer applied. All ⅝ × 2 and ⅝ × 3 redwood strips. Aluminum screen is 0.011-inch diameter wire in a 1/16-inch mesh. Add $60.00 for heavy-duty mesh, $50.00 for extra bracing and $100.00 for galvanized frame.

The heavy mesh (0.025 inch diameter wire, ⅛-inch mesh) is about 2½ times as heavy as the regular mesh and will withstand abuse by hail, ice, etc. much better than the regular mesh. The extra bracing is necessary if you plan to move the antenna about. It makes the framework very rigid.

The 12-foot 8-Ball with galvanized frame, heavy mesh and extra bracing is a commercial-grade antenna named "Octasphere" and is available for $1195.00. Feed horn (fits LNA with WR-229 input): Sheet metal with brass flange, $40.00; Aluminum $60.00 RG-213 cable (loss 25 dB/100 feet at 4 GHz), $0.50 per foot. FM-8 cable (loss 13 dB/100 feet at 4 gHz), $0.60 per foot. Avantek 120° LNA (50 dB gain) $690.00 including DC block; $650.00 without DC block. All prices are FOB, Salem, AR.