THE DIRECTIONAL BEAM ANTENNA

Winter is a good time to think about next summer's antenna project, so give your thoughts toward this compact 3-foot DIWA® X-longwave relay beam that features 34-foot shortened element, all-metal construction, a null-plane directional response, and remote population-like Pickup. Plan to use one or more of these features at your disposal and...

—Lighthouse Larry

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Modern design makes a big difference in this 1957 version of a beam antenna that has been quite popular for more than twenty years. The radiation pattern, shown in Fig. 1, is bidirectional, with a power gain of between 4 and 5 decibels over a tuned dipole. When the elements are made from loss-resistance conductors, the over-all length may be reduced to about 34 feet with practically no sacrifice in performance as compared to full-length H-shaped elements. Aircraft construction principles keep the total weight below 35 pounds. The antenna is constructed from the materials specified in the PARTS LIST.

Even though this antenna has about the same power gain as a well-tuned two-element parasitic beam, it is used in a different manner to take advantage of the sharp nulls shown on the radiation pattern. When receiving, the antenna is tuned so that interfering signals are placed in this null. Since the width of the main lobes in the pattern is about 30 degrees at the half-power points, the transmitted signal from the beam will be stronger than that from a dipole antenna even when the beam is aimed more than 40 degrees off the station being contacted. The construction will be covered later, but first, a word about this antenna's history is in order. The original design dates back to the middle 1930's and was known as the end-fire or "EBB" beam. During that era, the antenna elements were constructed from heavy copper wire stretched between wooden spreader bars. It was then either strung up horizontally between fixed supports like an ordinary flat-top antenna or else suspended vertically so that it could be rotated. The method of feeding power to the original end-fire beam was equally simple, usually just a tuned open wire line connected to points "A" and "B" on the schematic diagram of the beam, shown in Fig. 2. When the transmitter end of the feedline was terminated in a conventional antenna tuner, a frequency range of two to one could be covered with almost no change in the radiation pattern.

During the past ten years, this antenna has appeared in many different forms. Fig. 3 illustrates the "EBB-10" and upper. In this version, each of the two elements is a folded dipole made from parallel conductors. Most antenna handbooks give directional pattern and construction information on the above-mentioned beams. The null-plane directional response pattern is an outstanding feature of the end-fire beam that requires a bit of explaining. This pattern is shaped like two spherical objects just touching each other. An approximation of this pattern may be simulated by placing this page on a flat surface. Next, set a ping pong or golf ball on each half of the pattern of Fig. 2. A small piece of paper inserted vertically between the spheres at the point of contact represents this antenna's null plane. Thus, the actual antenna has very little response to signals arriving from the two directions in line with this null plane, either horizontally or at any other vertical angle. These signals are presented to feedpoints "A" and "B" 180 degrees out of phase and are greatly attenuated. However, signals arriving from other directions are only attenuated slightly, or are received stronger than with a single resonant dipole. The end-fire beam has been deliberately designed to have a bi-directional pattern in order to achieve this useful null plane that remains unchanged over at least a two-to-one frequency range.

If you have ever used a parasitic type beam for receiving sky-wave propagated signals, you may have noticed that signals arriving from directions behind or off the sides of the main lobe sometimes are surprisingly strong. This effect may have been caused by one or more factors. First, the parasitic beam has a null-plane directional response pattern. The shape of this pattern may be illustrated by holding a strip of paper over the faces of two棱长 isosceles triangles each 180 degrees apart. If you hold your fingers horizontally into one side of the ball. The radiation pattern is shown in Fig. 3A at the end of the beam pattern. The null-plane pattern as a null or a low point in the radiation. Thus, the beam will be immediately after the null, the nulls will be about 30 degrees above the center, the shape of these nulls is shown in Fig. 3A at the end of the beam pattern. The nulls above the center would have a much smaller radiation, representing a small swell at the rear of the beam. From the above example, it can be seen that the parasitic beam will pick up sky-wave signals that arrive from the sides and rear of the antenna much better than other beams.
nuts. Most hardware stores that stock the aluminum single-axle have them. Experienced constructors may wish to predrill some of the joint holes, but the possibility of drilling holes in the wrong locations is greatly reduced by following this procedure:

First, align the pieces in each joint properly, fasten with a clamp and drill a 1/4-inch diameter pilot hole through them. Second, remove the clamp and enlarge the hole in the piece that will be next to the bolt head with a 9/32-inch diameter drill. Third, enlarge the hole in the other piece with a No. 6 drill, then thread it with a 1/4-20 tap.

As each joint is assembled, the bolt is not tightened completely until the whole framework has been assembled. Then, all bolts are tightened and an aluminum nut is run onto each to serve as a locking device. This will keep vibration from loosening the frame joints. If aluminum hardware is not readily available, galvanized steel bolts and nuts are permissible. With either type of hardware, all joints should be protected with a coat or two of aluminum paint.

**ELEMENT SUPPORT TRUSSES**

Predrill 9/32-inch diameter holes for the element insulators in the top ribs of part 3 1/2-inch from both ends and 1 1/4 inches each side of center, as pictured in Figs. 6 and 7. These views also show the following steps. The

**MATERIAL LIST**

- 12-6-foot lengths of 1/4 x 1/4 x 1/8-inch wall aluminum angle (Reynolds aluminum Co., Inc., 71).
- 8-6-foot lengths of 1/4 x 1/4 x 0.030-inch aluminum channel (Reynolds Co., Inc., No. 14 brace for screen frame).
- 4-12-foot lengths of 7-inch diameter x 0.031 to 0.038-inch wall aluminum tubing, 81556.
- 1-Aluminum pipe 12 x 19 inches, 1/4-inch thick.
- 8-Standard piler insulators with threaded holes in ends, 1/4 x 1-inch diameter, 2 inches long.
- 8-Polyethylene drinking glasses 2 inches in diameter.
- 1-Polyethylene refrigerator box about 5 inches square and 6 inches high.
- 8-Element clamps made from 0.031-inch thick aluminum, 1 inch wide and 4 1/2 inches long.
- 1-Capacitor support bracket made from 0.062-inch thick aluminum 1 inch wide and 4 1/2 inches long.
- 32-1/4-20 x 1/4-inch long aluminum bolts and nuts.
- 24-10-24 x 1/4-inch long aluminum bolts and nuts.
- 1-3-foot length of 3-inch steel pipe (1 1/4 inches outside diameter, 1 3/16- or 1 1/4-inch pipe may be needed to fit some rotators).
- 1-Flue grate to match size used for mast.
- 1-4-foot length of No. 10 copper wire for matching stub.
- 1-Butterfly wall-clamp variable capacitor, 6-kilowatt per section, 0.030-inch air gap (Vermontville BPC-38, or Johnson 30/813, Cat. No. 167-23).
- 2-Insulated flexible couplings.
- 1-4-inch length of 3/16-inch diameter brass or fiber sheathing.
PARTS LIST

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>NO. SIDS</th>
<th>OVER ALL LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>63 inches angle</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>67 1/4 inches angle</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>72 inches angle</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>72 inches angle</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>6 inches angle</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>6 inches angle</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>23 1/4 inches angle</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>13 inches channel</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>63 inches channel</td>
</tr>
</tbody>
</table>

upper end of part 5 is then fastened to the center of part 3. Cut off both ends of the bottom rib on the part 4 piece as follows: part 4, 1 inch; and part 6, 1/2 inch. Then fasten the center of part 6 to the lower end of part 3. Next, cut a narrow notch in the center of the side rib on part 4. Bend part 4 so that it fits against part 6, as shown in Fig. 6, with the ends overlapping part 3, as shown in Fig. 7. Then fasten part 4 with two bolts into part 6 and two more at each end into the side rib at each end of part 3.

DOOM ASSEMBLY

Locate the center of the 12 1/2-inch aluminum plate and draw two radial lines at an angle of 30 degrees with the long sides. Pencil the pipe flange at the plate's center and draw holes in the capacitor bracket, clock motor and its extension shaft. Lay the plate and the element trays upside down in their correct positions on a large flat surface, such as a cellar or garage floor.

Trim the top rib of the part 1 pieces to a 20-degree angle, then clamp them 1/2 inch from the ends of part 3 on the element trays. The other ends of part 1 are then laid along the radial lines on the plate with their ends 4 inches from the plate's center, as shown in Fig. 8. Before fastening these pieces to the plate, measure the distance between the element supports on both sides of the boom. These distances should be equal, otherwise the beam elements will not be parallel.

Assemble each part 1 piece to the plate with two bolts, then screw the pipe mast into the pipe flange. Stop in a position at which the pipe is square with the plate, then drill and tap a 1/4-20 hole into both flange and pipe for a locking bolt. Draw four lines up the pipe in line with each part 1 piece (the boom is still upside down) and assemble the part 7 brackets to the pipe on three lines ten inches from the plate. Clamp a part 2 piece to each part 7 and assemble, as shown in Fig. 6. Cut off 1 1/4 inch of the bottom rib at the outer end of part 2 where they contact part 1, as shown in Fig. 7. Make sure that the entire frame is not warped or crooked, then assemble each part 2 piece to its respective part 1.

Turn the frame right-side up, clamp the part 8 cross braces to part 3 adjacent to each part 1 and assemble with a 1/4-20 bolt. Clamp the other ends to the plate so that each pair of braces crosses, and lastly, fasten the plate with two 1/4-20 bolts. Finally, fasten each part 1 piece to its respective part 2 piece with a 1/4-20 bolt. The completed framework may be moved outdoors after the matching network is installed, but before attaching the antenna elements.

FINAL ASSEMBLY

The butterfly variable capacitor, C1, is mounted over the extension shaft hole with a bracket made from 1/16-inch thick aluminum, as shown in Fig. 9. Most small 1-HP clock motors will need to have a short piece of 3/8-inch diameter brass rod soldered to the shaft. Then, the motor is mounted below the plate to protect it from the weather. It turns the capacitor through a flexible coupling and short extension shaft. A 3-cubic-inch refrigerating box almost 1 inches square and 6 inches tall was inverted over the capacitor for protection. Short lengths of heavy wire run from the capacitor staters to bolts which pass through the box wall. One-half-inch wide aluminum strips connect these bolts to the passing lines.

Form eight, cement clamps from short aluminum at least 1/32 of 1/2 inch thick, as shown in Fig. 7. Drill a 1/16-inch hole in each clamp and secure with an 1/8-inch bolt which it is slipped over at each element. Mount the element insulators on part 3 of the element truss, using bolts that match.
REDDUcing FLuorescent lamp QRM

Do nearby fluorescent lamps cause plenty of QRM in the broadcast receiver around your house? Or perhaps even on the apatuer bands in your car? If so, there may be several possible sources. In some cases, the noise is reduced or eliminated if you will observe a few precautions when installing these lamps. The same precautions apply equally to fluorescent lamp fixtures that already are in use.

Well, why does a fluorescent lamp create this interference? Simply because it is essentially a mercury arc discharge device that is automatically turned on and off 120 times each second operated on 60-cycle AC power. The mercury arc within the glass tube causes an arcing or sparking action at the lamp electrodes, thus setting up a series of radio waves. This RFI energy is radiated in one or more of the following ways:

1. Direct radiation from the mercury arc.
2. Radiation from the power line near the lamp.
3. Feedback through the power line to the radio.

The intensity of noise generated varies considerably among identical lamps, as well as those of different wattage ratings. In most cases, the total amount of noise produced by a multiple-lamp installation will be very little more than that of the single lamp of the group that produces the most noise. The broadcast frequencies from 0.33 to 1.6 megacycles are most affected by this noise, as the graph below indicates.

![Graph showing noise spectrum of a 40-watt fluorescent lamp. Lamps having different wattages, rating at unusually will have peaks of noise output at other frequencies.]

**DIRECt Radiation**

The radio energy radiated by a fluorescent lamp usually is dissipated within a few feet and therefore can be controlled by sufficient spacing between the lamp and the radio or its antenna.

If the radio must remain within the bulb radiation range, the following precautions should be taken:

1. Install an antenna that is outside the noise area, connect it to the radio through a shielded lead-in cable and ground the shield. Reducing noise in a radio equipped with an inside antenna is more difficult. Usually, the noise can be cancelled out by turning the radio to a certain position. However, some radios of this type are equipped with a separate antenna connection to which the shielded antenna lead-in wire may be attached.
2. Provide a good ground for the radio.

Receivers having a "hot" chassis—one that is connected to one wire of the power cord—should have a 0.1-mfd, 600-volt capacitor in series with the ground lead at the chassis.

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Commercially-made filters designed especially for fluorescent lamps are made by several firms. Among these, General Electric has two types that use the above circuit. One is the catalog number 23F214, designed for permanent lamp installations. The other, catalog number 23F806, is recommended for portable lamp fixtures. Your local GE Apparatus Sales office will tell you where they can be obtained. Another type which should be available from most radio parts distributors is the Springet SP-37.

Direct radiation noise from a fluorescent lamp can greatly be reduced by shielding the lamp bulb. Since many fixtures partially enclose the bulb, complete shielding is possible simply by fitting a piece of aluminum screening across the opening and grounding it to the fixture. Obviously, the screen will absorb some light, and it will be necessary to choose a color for maximum reduction of interference and minimum absorption.

Don't put up with that hash any longer! Examine these remedies suggested by General Electric's Lamp Department—install any necessary filters and shielding—then enjoy clear reception on your home and ham shack receivers!

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Here's some information that you may pass along to your local radio club secretary concerning these two types of program material which General Electric will loan to amateur radio clubs, novice radio classes and other groups interested in electronics.

... The first is a tape recording of the 1955 Edison Radio Amateur Award presentation ceremony. It's a 35-minute program during which Herbert Hoover, Jr., W2EHP, and former FCC Commissioner Edward M. Webster have many kind words to say about Bob Morris and his award. In addition, they ran in a few bouquets about the many first services with which all radio amateurs contribute to the community. As long as he's writing, have him ask me for the catalog of educational and technical stock motion pictures and slide films that can be shipped to your group from eighteen G-E Film Libraries strategically located throughout the United States. These films are loaned at practically no charge (just return postage). The address to which your secretary may write for films is listed in the back of that catalog.

... While we're on the subject of club programs and tape recorders, there are many ways in which a tape recorder can be used to advantage at many club meetings. Our local club recently put on a "CW MAN'S NITE," during which tape recorded code messages and other information was played back to the audience. The recording even demonstrated how a CW traffic net could work in the field and included a step-by-step voice narration.

... Thanks to all those generous radio club paper editors and secretaries who send me each issue of their club paper or bulletin. I read them all thoroughly and am amazed at the commercial appearance of some publications. The boys who run the editorial and production staffs of these papers really deserve a big vote of thanks from the membership which they serve. We swap G-E HAM NEWS with these radio clubs and use this interchange as a source to exchange ideas for your own club paper.

... Always keep the usual news coming about club programs, group columns and ARRL bulletins, some clubs report the activities of each group within the club, such as DX, VHF, traffic, emergency Civil Defense, etc. One type of feature which I heartily endorse are technical articles describing simple, handy electronic gadgets that the local boys have dreamed up. So if you have developed a little black box that makes life easier around your ham shack, give your club paper editor the gory details.

... At the present moment, the volume in reducting radio code and theory classes for novices, but one club goes even further. According to an article in the latest edition, the members have rounded up a lot of spare parts, applied some collective elbow grease, and now own a few crystal-controlled CW transmitters for the 7.15 and 31.3-megacycle novice bands. When a novice in the area gets his license, they loan him a transmitter until he can get a rig of his own on the air. They say that this gets novices on the air sooner and gives them more CW operating experience in preparation for that 15-word-per-minute general class examination.

... A similar system could be set up for loaning simple receivers to those prospective novices who do not have a receiver, but who may wish to take advantage of code practice now being transmitted by many amateur stations. Again, the most useful junk boxes in your club could be raided for parts to build a few simple "check receivers" and set them up in the regular monthly meetings.

... A brief summary of this report is as follows: Build a 5 inch cathode ray tube to use in this circuit. The answer is— yes! There are even 5-inch CRTs sold. They have been going so fast that our binoculars have run out of them, so we have to be very careful handling them. If you haven't seen previous announcements, all thirty of these vacuum tubes have been in stock for over a year. Through 1955 have been built into a 350-page book having still images for identification in the index listing of all information in the book also is included. The cost—$1.00, postpaid.

-- Elbridge Lawrence
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then to the elements with 10-24 bolts, placing the nut inside the end of the tubing.

The matching stub is shaped from a single length of No. 10 wire with an initial spacing of one inch. Bend the open ends to the soldering tags on the phasing line. Support the closed end on a small steatite pillow insulator if a balanced feedline will be used, as shown in Fig. 8. However, if you plan to use coaxial cable, shape the matching stub so that the first few inches from the closed end are close to the aluminum plate and ground this end to one of the pipe flange bolts shown in Fig. 8.

ADJUSTMENT PROCEDURE

Since the element heights need not be adjusted, final tuning is done in two simple steps. First, the matching stub is resonated in the 14-megacycle band with a grid-dip meter. Second, set the feedline at a position on the stub that results in a minimum standing wave ratio on the line. These adjustments may interact, and each should be repeated a few times. Tuning should be done at the height at which the beam will be operated for best results, although an initial adjustment may be made with the antennas only a few feet off the ground.

Set capacitor C2 to maximum capacity and check the resonant frequency of the stub with the grid-dip meter. If the stub resonates below 14 megacycles, more coil turns will be needed before the resonant frequency will be high enough. Then, assuming that a balanced feedline will be used, attach a line which will resonate the antenna and readjust it to 14 megacycles if a change in the tuning was noted. Next, connect a standing wave ratio meter and stable source of 14-megacycle RF energy to the other end of the feedline. Measure the standing wave ratio on the line, then shift the position of the feedline on the matching stub for a minimum reading. Repeat this step until the lowest standing wave ratio is measured with the stub resonant at 14 megacycles.

Now, shift the RF signal source to about 14.3 megacycles and again measure the standing wave ratio on the feedline. Then, apply power to the match- ing stub and check the standing wave ratio. As the excitation is increased, the standing wave ratio decreases as capacitor C2 turns toward minimum capacity. It should be possible to measure a very low standing wave ratio throughout the 14-megacycle band simply by rotating the capacitor, once the feedline is matched to the antenna. The components have been chosen to handle the output from a full "gallon" plate modulated transmitter on this band when the beam is tuned.

The antenna may be fed with coaxial cable by following these steps: First, ground the matching stub as previously described. Next, aim about three inches of the coaxial cable, twist the braid into a single conductor and seal the cable's end with plastic electrician's tape. Solder the coaxial cable braid to a large waterling bag and fasten it to the aluminum plate where the pillar insulator is shown. Then tap the inner conductor of the coaxial cable onto one wire of the matching stub about 5 inches from the closed end for 35-ohm cable, and 6 inches for 72-ohm cable. Follow the steps outlined for balanced feedlines to obtain a minimum standing wave ratio on the cable.