Winter is a good time to think about next summer's antenna projects, so direct your thoughts toward this compact 2-element 14-megacycle rotary beam that features: 24-foot foreshortened elements; all-metal construction; a null-plane directional response; and remote transmission line matching. Plan to use one or more of these features at your station soon!

—Lighthaulin' Larry

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- Directionull Beam Antenna ................................................. page 2
- Reducing Fluorescent Lamp QRM ............................................. page 6
- Sweeping the Spectrum ....................................................... page 7
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 low-resistance conductors, the over-all length may be reduced to about 34 feet with practically no sacrifice in performance as compared to full-length 14-megacycle elements. Aircraft construction principles keep the total weight below 55 pounds when the beam 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 null. Since the width of the main lobes in the pattern is about 70 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 bearing 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 "126" beam. During that era, the antenna elements usually 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. 3. 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 still another way, as shown in the schematic in Fig. 2. 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 beam.

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 approxima-

**Fig. 1.** Measured polar plot response pattern of this antenna. Actual gain at the outside circle is between 4 and 5 decibels over a tuned dipole. **Fig. 2.** Schematic diagram of the DIRECTIONAL antenna showing a few dimensions, phasing lines and feedpoints "A" and "B."
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inch

because a model, an over-all length illustrates the true wish greatly elongated simply when this narrow

Fig. 4.

When the narrow fed classic voltage and the antenna, the "Q" is about 1 inch. For 72-ohm twin lead, dimension "A" is about 18 inches, and "B" is about 6 inches. The over-all slug length is the same for other fundamentals, but the top position may change.

MECHANICAL DETAILS

A rotary antenna having insulated elements requires a different construction technique than a 'pumper's delight' antenna in which the elements are attached directly to a metal beam. It is desirable to have each pair of element insulators spaced several feet apart to reduce element overlap beyond the outer insulator. Simple stellite pillar insulators having a threaded hole in each end were found to have adequate strength to withstand considerable element deflection. This is important if you live where high winds or storm areas are encountered. Leakage across the insulators in wet weather is minimized by placing an inverted polyethylene plastic cup over each insulator. A truss-type design was used for both the element supports and the main boom framework. Each half of the boom is triangular in shape, as shown in page 1, instead of the usual ladder-type boom. This frame is surprisingly strong even when constructed from the same kind of materials. Two identical frames, as shown in Fig. 5, are constructed and fastened to a 12/16 x 3 4/16-inch thick aluminum plate. A standard aluminum rack joint, or any similar semi-hard aluminum plate, is suitable. On this model, a 2-inch horizontal wire is attached to the plate. The antenna was then mounted on a short length of a 3/8-inch OD hose capped and painted a standard television antenna rotor. Smaller diameter pipe, 1/2" or 1/4" inch, may be used to fit the particular rotator on which the antenna will be mounted.

ASSEMBLY

First, accumulate all items in the MATERIAL LIST and cut the aluminum angles to the lengths given in the third column of the PARTS LIST. The 3-Inch lengths left over from the 6 45-inch long part 1 pieces are used for parts 3 and 6. Similarly, the two ends from part 2 are used for the part 7 pieces that attach to the pipe mast. The frame beam is put together in three steps; first, the element support trusses and the boom framework; and third, the elements, phasing lugs and matching stubs all mains in the framework are shown and numbered on the assembly drawing, Fig. 5. All joints in the boom framework are fastened together with 1/2 x 20 1/2-inch long aluminum bolts and

Fig. 3. Rectangular pulse response pattern. The "DB" curve illustrates the same data as the polar plot, Fig. 1. Note that the "Power" curve is nearly a sine wave.

Fig. 4. Schematic diagram of the matching stub for use with amateur antennas. The spacing "D" is about 1 inch. For 72-ohm twin lead, dimension "A" is about 18 inches, and "B" is about 6 inches. The over-all slug length is the same for other fundamentals, but the top position may change.
nuts. Most hardware stores that stock the aluminum angle also 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 1/2-20 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.

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

4-12-foot lengths of 1/2 x 1/4-inch wall aluminum angle (Reynolds aluminum Cat. No. 71).

8-6-foot lengths of 1/8 x 1/4-inch 0.020-inch aluminum channel (Reynolds Cat. No. 18 brace for screen frame).

4-12-foot lengths of 1-inch diameter x 0.031 to 0.036-inch wall aluminum tubing, 61556.

1-Aluminum plate 1/4 x 19 inches, 3/8-inch thick.

8-Stellite piller insulators with threaded holes in ends, 1/8 to 1-inch diameter, 2 inches long.

8-Polyethylene drinking glasses 2 inches in diameter.

1-Polyethylene refrigerator box about 3 inches square and 6 inches high.

8-Element clamps made from 0.031-inch thick aluminum, 1 inch wide and 4 3/4 inches long.

1-Copper support bracket made from 0.062-inch thick stainless steel 1/4 inch wide and 4 3/8 inches long.

22-3/20 x 1 1/2-inch long aluminum bolts and nuts.

24-10-24 x 1 1/4-inch long aluminum bolts and nuts.

1-3-foot length of 2-inch steel pipe (3/8 inches outside diameter, 1 1/2- or 1 1/4-inch pipe may be needed to fit some rotators).

1- Pipe flange to match size of pipe used for mast.

1-4-foot length of No. 10 copper wire for matching stub.

1-Butterfly split-stem variable capacitor, 36-leaf per section, 0.020-inch air gap (Hammarlund BFC-38, or Johnson 50LB15, Cat. No. 167-23).

2-Insulated flexible couplings.

1-4-inch length of 3/16-inch diameter brass or fiber shafting.
upper end of part 5 is then fastened to the center of part 3. Cut off both ends of the bottom ribs on the part 4 and 6 pieces as follows: part 4, 3 1/2 inch and part 6, 1 1/2 inch. Then fasten the center of part 6 to the lower end of part 5. 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 5, shown in Fig. 7. Then fasten part 4 and two bolts into part 4 and two more at each end into the side rib at each end of part 3.

**ROOM ASSEMBLY**

Locate the center of the 12 x 10-inch aluminum plate and draw four radial lines at an angle of 30 degrees with the long sides. Fasten the pipe flange at the plate's center and drill holes for the capacitor bracket, clock motor and its extension shaft. Lay the plate and the element trusses 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 30-degree angle, then clamp them 5 1/2 inches from the ends of part 3 on the element trusses. The other ends of part 1 are then laid along the radial lines on the plate with their ends 6 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.

### PARTS LIST

<table>
<thead>
<tr>
<th>PART NO.</th>
<th>NO. SIZE'S OVER ALL LENGTH</th>
<th>MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>65 inches</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>67 1/2 inches</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>72 inches</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>72 inches</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>6 inches</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>6 inches</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>2 1/4 inches</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>63 inches</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>63 inches</td>
</tr>
</tbody>
</table>

### Illustrations

- **Fig. 8.** Bottom view of the aluminum mounting plate showing the braces attached to the pipe mast and matching stub insulators. The clock motor that drives the capacitor is mounted on metal pillores 2 inches from the center of the plate.

- **Fig. 9.** Detail view of the matching stub tuning capacitor with the polyethylene box removed. The box is fastened to the plate with small angle brackets, then sealed with an aluminum caulking material compound used for sealing joints between aluminum gutters.

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 1/2-20 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 these lines ten inches from the plate. Clamp a part 2 piece to each part 7 and assemble, as shown in Fig. 8. Cut off 1 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 twisted, then assemble each part 2 piece to its respective part 1.

Turn the frame right-side up, clamp the part 8 cross braces in part 3 adjacent to each part 1 and assemble with a 10-24 bolt. Clamp the other ends to the plate so that each pair of braces cross, and fasten them to the plate with two 10-24 bolts. Finally, fasten each pair of braces by each part 2 and 3 to the plate, and assemble the entire frame with 10-24 screws, as shown in Fig. 7. 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, C, is mounted over the extension shaft hole with a bracket made from 1/16-inch thick aluminum, as shown in Fig. 8. Most small 1-RPM clock motors will need to have a short piece of 1/4-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 polyethylene refrigerator box about 3 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 well. One-half inch wide aluminum strips connect these bolts to the phasing lines.

Form eight element clamps from short aluminum at least 1/32 of an inch thick, as shown in Fig. 7. Drill a 1/8-inch hole in plate, and run a 1/8-inch diameter bolt through it if it is slipped over an element. Mount the element insulators on part 3 of the element truss, using bolts that match...
REDUCING FLUORESCENT LAMP QRM

Do nearby fluorescent lamps cause plenty of QRM in the broadcast receiver around your house? Or perhaps even on the greater bands to your stations? Here's how to check for possible QRM in your receiver. The test itself is extremely simple: Glue or otherwise firmly attach thin paper to the inside of the lamp (this will prevent paper or cloth from becoming reduced or eliminated if you will observe a few pre-
calculations when installing these lamps. The same rem-

Omit the method for reducing both line radiation and feedback is to place a filter at each lamp or fixture.

For most household type lamp fixtures, a simple delta-
copied capacitor network, as shown below, is suffi-
cient. The value of the 1.6 mfd. capacitors should be the
possible to the line side of each lamp ballast. Typical
capacitor values are Ci across the power line 0.02 mfd.
C2 and C3, 0.002 mfd. The grounded connection be-

NOTE FILTERS

This particular curve represents the noise spectrum of a typical 40-watt fluorescent lamp. Lamps having different wattage ratings usually 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, con-
nect it to the radio through a shielded lead in cable and
ground the shield. Reducing noise in a radio equipped with a transformer makes the most effective. Usually,
a fluorescent lamp noise can be canceled 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 lead and wire may be attached. (2) Provide a good ground for the radio. Receivers having a "hot" chassis—one that is con-
tected 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.

DIRECTIONAL BEAM ANTENNA

The threaded hole in the insulator. Trim off the lip of the polyethylene cups to clear part 3 by at least ½ inch and cut 9.32-inch diameter holes in the bottoms. Place a cup atop each insulator, followed by two
washers, and clamp the elements to the insulators.

Cut the part 9 phasing line pieces to size, then clamp each one in a vise and twist it to form permanent 90-
degree twists in all four pieces. This will place the center
of the phasing line in a vertical plane where it attaches to the polyethylene base. Next, clamp each pair of chan-
els together, allowing enough overlap so that the ends may be fastened to the middle of the elements. Join each pair of channels with four 10-24 bolts, and insert the short aluminum strips in the bottom flange as shown in Fig. 9. Also place large soldering lugs for the matching each side of the heatsinks. Assemble the center line spacing. The ends of the channel strips should be shaped to fit the tubing snugly. Then fasten

4

6

FIG. 7

This page contains a diagram labeled "NOISE OUTPUT"

FIG. 8

This page contains a diagram labeled "DIRECT RADIATION"

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4

6
Here's some information that you may pass along to your local radio club secretary concerning 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 25-minute program during which Herbert Hoover, Jr., W2HD, R&SEV, and former FCC Commissioner Edward M. Webster have many kind words to say about Bob Gunderson, W2JHJ, the 1955 Award winner. In addition, they toss in a few bon mots about the many fine services with which all amateurs serve the public. As long as he's writing, why don't they ask me for the cutout description of these radio operators who have operated your radio club's transmitters and slide films that can be shipped to your group by first-class mail from the Edison Radio Amateur Award groups throughout the United States. These films are loaned at practically no change (just return postage). The address to which your secretary may write for films is listed in the back of this catalog.

- While we're on the subject of club programs and tape recorders, there are many ways 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 operator learns on to finish and included a step-by-step voice narrative. These generous radio club paper editors and secretaries who send me each issue of their club paper or bulletin. I read them all throughly and am amazed at the commercial appearance of some publications. The boys who make 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 will be glad to do the same exchange for a copy of your own club paper.

Again, the usual news about coming club programs, going 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 column which I heartily endorse are technical articles describing simple, handy electronic gadgets that the local boys have dreamt up. So if you have developed a little black box that makes life easier and the gang can use, send it on along with your club paper editor the galvanic details.

We're going to begin conducting radio code and theory training classes for novices, but one club goes even further. According to an item in their club bulletin, 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 3.7, 7.15 and 11.2-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 13-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 more fruitful junk boxers in your club could be raised to parts to build a few of the simple receiver designs that have been described in amateur radio journals lately. Bring up this worth-while subject for a club project at your next meeting.

- If you have any other schemes for keeping your club members busy, send them in and I'll pass them along in this column.

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I have just answered several letters from fellows who wish to build the "HAMSCOPE" (see G-E HAM NEWS, Vol. 11, No. 5, September-October, 1955, for details) around other types of cathode ray tubes that have been lying idle in their spare parts boxes. In some cases, these tubes have the cathode connected internally to one side of the tube heater. The original circuit diagram on page 3 of that issue must be changed slightly to utilize these tubes. The separate cathode on the 3KP1, pin 2, was connected to the anode on the "INTENSITY" potentiometer through a 1-megohm current limiting resistor. The circuit should be changed as follows: First, the end of that 1-megohm resistor should be removed from pin 3 and connected to one side of the cathode ray tube heater. Second, the lead from the control grid, pin 2, to the voltage divider network should no longer be connected to the heater circuit.

Bring another big idea: Can a 5-inch cathode ray tube be used in this circuit? And the answer is—yes. If you wish to utilize these tubes.

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That supply of the G-E HAM NEWS SECOND ROUND VOLUME is doing fast, so if you wish to have a copy, an order for it should be placed soon. They have been going so fast that our library has really worked to keep up with the demand. In case you have not received the latest issue of the "SWEEPING THE SPECTRUM", a special offer has been made and it has been bound into a 250-page book having still more exciting, useful and needed articles. A really worthwhile listing of all the information in the book also is included. The cost—$1.00, postpaid.
If the RF energy source, again check the resonant frequency of the stub with the grid-dip meter and adjust the conductor spacing if necessary. Recheck the standing wave ratio on the feedline and change its position on the stub for a minimum reading. Repeat each 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 clock motor to begin the resonance. Note that 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 "gallop" 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, skin 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. Braid the coaxial cable braid to a large soldering lug 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 52-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.

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. Turn off the RF energy source, again check the resonant frequency of the stub with the grid-dip meter and adjust the conductor spacing if necessary. Recheck the standing wave ratio on the feedline and change its position on the stub for a minimum reading. Repeat each step until the lowest standing wave ratio is measured with the stub resonant at 14 megacycles.

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