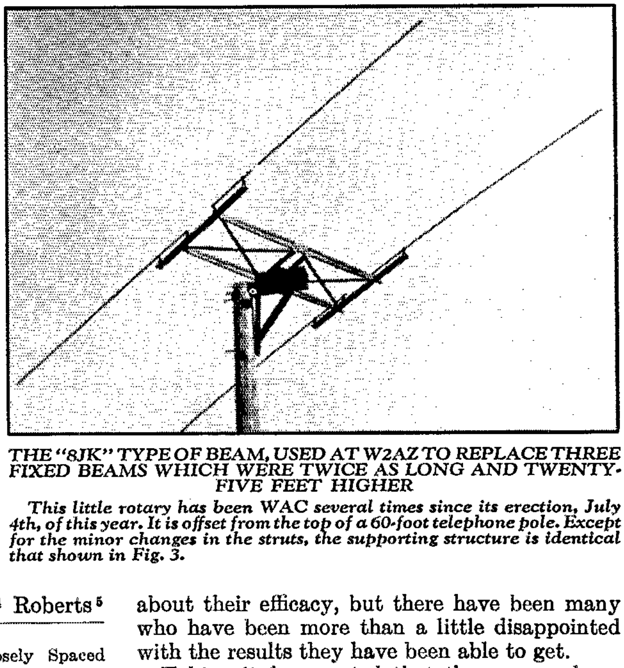
Some Thoughts on Rotary Beam Antennas

A Lightweight and Inexpensive Supporting Frame Adaptable to Several Types of Arrays

By Arthur H. Lynch,* W2DKJ

SO MUCH has been written and discussed over the air, among amateurs, regarding the design, construction and operation of rotary beams, that it would seem that any further conversation on the subject would be practically useless. The same might be said of matching stubs, transmission lines and the various forms of mechanical structures which have become so popular. At the outset, let us say that the fellow who expects to find anything very revolutionary in this text will be wasting his time. It is not our purpose to provide any thrills, but we do believe that a few practical ideas may be had from our own experience and that of others who have been using beams to good advantage.

Little doubt remains that the simple beam which has been so thoroughly described by John Kraus,[1] W8JK, is a much more satisfactory antenna than any of the simpler affairs which were used before he showed how easy it was to build and tune a good beam. The same may be said of Mims's Signal Squirter,[2] and some of the close-spaced arrays so well covered by Brown,[3] Romander,[4] Roberts[5] and others. Nearly every one of them has been duplicated many times by other hams, in practically every part of the world. There is no doubt about their efficacy, but there have been many who have been more than a little disappointed with the results they have been able to get.

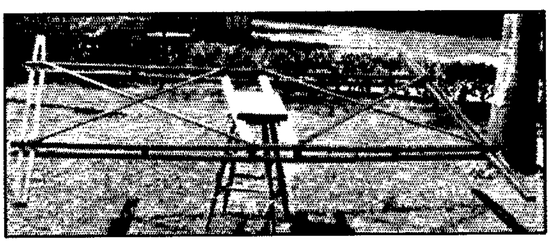


THE "8JK" TYPE OF BEAM, USED AT W2AZ TO REPLACE THREE FIXED BEAMS WHICH WERE TWICE AS LONG AND TWENTY-FIVE FEET HIGHER

This little rotary has been WAC several times since its erection, July 4th, of this year. It is offset from the top of a 60-foot telephone pole. Except for the minor changes in the struts, the supporting structure is identical that shown in Fig. 3.

Taking it for granted that the average ham, particularly the fellow who inhabits the 20-meter 'phone band, has a pretty fair idea of what it is all about and that he can actually follow the instructions which have been so ably set forth, we believe that the principal reason for dissatisfaction is found in the fact that the new beam user expects too much. To make our point a bit clearer, let's make one statement and then analyze it a bit. Then, perhaps, the other points will stand out a little more plainly.

One of the beams shown in the diagrams is a bidirectional affair, which may be either fixed or rotary. It has a gain of about 4.5 db over the ordinary half-wave dipole, and it will be recognized at once as being a typical "8JK" affair. The particular one, from which many of our facts have been drawn, has been in operation at W2AZ since the fourth of July. One of the receivers used at



LOOKING AT THE W2DKJ UNIT FROM THE BOTTOM

The platform is upside down in this view, to show how all the members have been joined.

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* 136 Liberty St., New York City.

[1] Kraus, "Directional Antennas with Closely Spaced Elements," *QST*, Jan. 1938.

[2] Mims, "The All-Around 14-Mc. Signal Squirter," *QST*, Dec., 1935.

[3] Brown, "Directional Antennas," *Proc. I.R.E.*, Jan., 1937.

[4] Romander, "The Extended Double-Zepp Antenna," *QST*, June, 1938.

[5] Roberts, "The Compact Uni-Directiona Array," *Radio*, Jan., 1938.

that station is an HRO, which has been very accurately calibrated in microvolts. Here is the statement: In an actual test with LU8AB, the measured signal put the meter needle against the pin, when the beam was smack on him, but his signal strength was so weak when the beam was turned 90 degrees in either direction, that it could not be observed on the meter.

That statement is as true as gospel, but it is only half the truth. It is the kind of enthusiastic

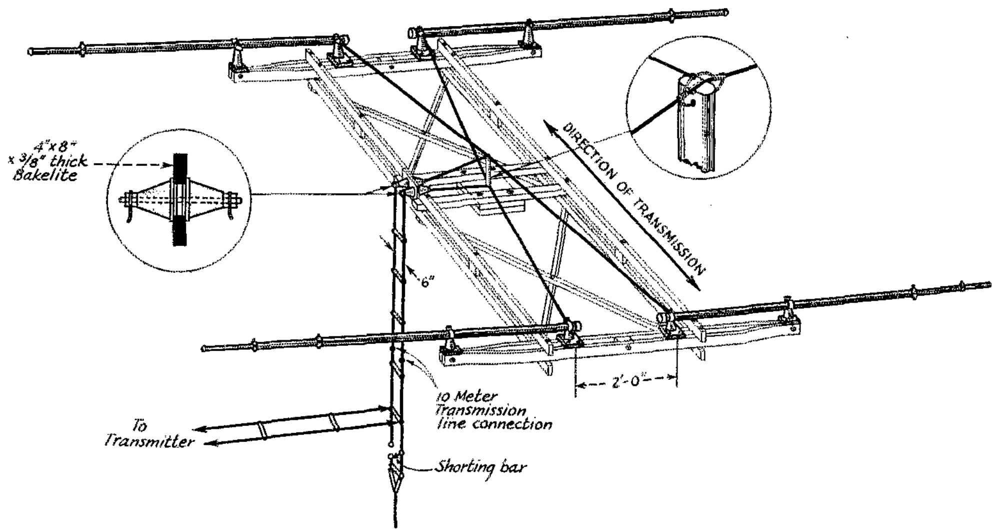


FIG. 1—BIDIRECTIONAL ANTENNA AT W2AZ

This is an actual drawing of the electrical arrangement used at W2AZ, on twenty-meter 'phone. The beam will have a bit better gain when used on ten meters, and it only is necessary to open the shorting bar on the matching stub and run the transmission line up to the points indicated by the dots. The shorting bar is used for twenty-meter operation.

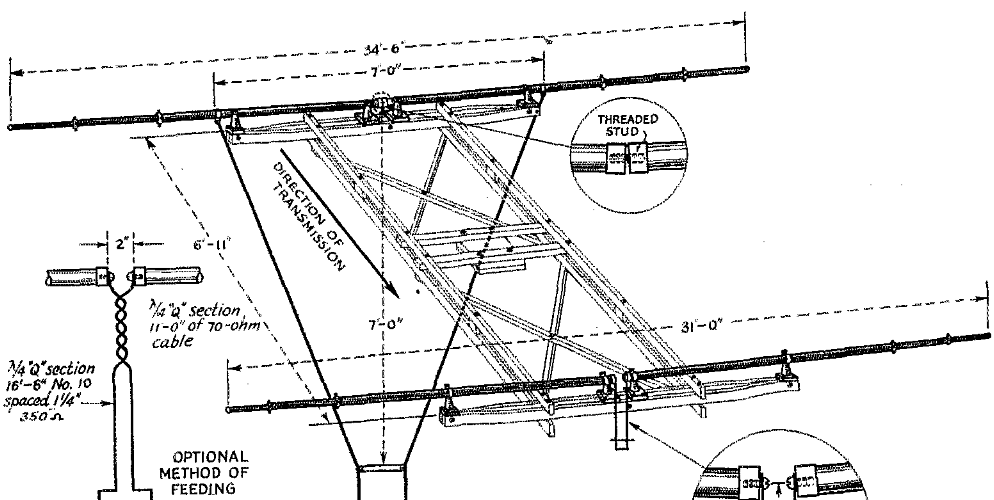


FIG. 2—UNIDIRECTIONAL BEAM ANTENNA

This is a compromise type incorporating some of the principles outlined by Brown, simplified by Roberts, and applying a few additional kinks suggested by the present author.

statement which has caused much of the misunderstanding of what we can and what we can't expect from these new marvels. At the time that particular test was made, conditions between New York and Buenos Aires were not what would be called "open" and the beam really had a chance to do its stuff. Let's suppose that we were to let the statement go at that and began casting that kind of oil on the troubled waters, giving all the dope on the construction of the beam itself, the matching stub and the transmission line. If the same sort of results were not experienced by the fellows who duplicated it they would have fair reason to assume that they were saps or that we were a liar.

Actually, neither of these things would, necessarily, be true. Most of us forget that the various bands play some funny tricks on us, particularly when we are really out for the "far corners." While the result we have mentioned was an actual occurrence, it is not average—not by a very long shot. If, for instance, conditions between B.A. and N.Y. began to improve, we should have found that the beam would be less and less efficacious and it is quite likely that a wide-open condition between the two cities, when low-powered rigs, hooked to ordinary aerials, on each end were bringing reports of S9, that we could swing the old beam around as much as we liked and the signal level would be about the same or not much different. It is doubtful that any condition would arise which would quite come into this category, but the point is that we would not be getting anything like the results we thought a good beam should be capable of giving compared to our ordinary aerial, and would be somewhat less than satisfied.

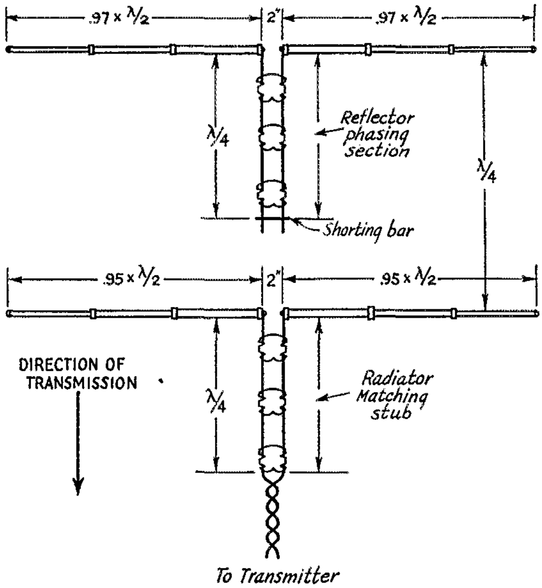


FIG. 4—TEN-METER 4-ELEMENT ARRAY USING TWO HALF-WAVES IN PHASE AND TWO HALF-WAVE REFLECTORS

Using the same supporting structure, without making any important changes in the dimensions, it is possible with the use of rigid telescopic elements to build a uni-directional, multi-element array which has considerable gain. Approximate dimensions for 30-Mc. reflectors, 16'–7" each; antenna element, 15'–6" each; reflector phasing section 8'–1½"; radiator matching stub 8'–0"; distance between radiators and reflectors (λ/4) 8'–2½".

Let's figure, then, that there is still room for a good transmitter with real power behind it and that no matter how well our beam is constructed and tuned, it is not going to give us the earth on a silver platter if we insist on using a couple of watts. On the other hand, it is surprising to watch the color change from white through rose to crimson in the cheeks of some of the California Kilowatters when the hundred-watter around the corner makes his rotary beam put them to shame on the income and the outgo.

The second reason why many beams perform fewer miracles than is expected from them is the slip-shod manner in which the mechanical details are executed. "Executed" is just about the word for it, by the way.

So much has been written about the various types of beams and the results which have been obtained with them that there is little use in reviewing that subject here. Rather, we shall tell how some of the mechanical details have been worked out and indicate how they may be duplicated with but little expense and moderate ability in the handling of some of the simpler carpenter's tools.

The rotary beam shown in the photograph has been in use at W2AZ since the fourth of July. That station is operated with about eight hundred

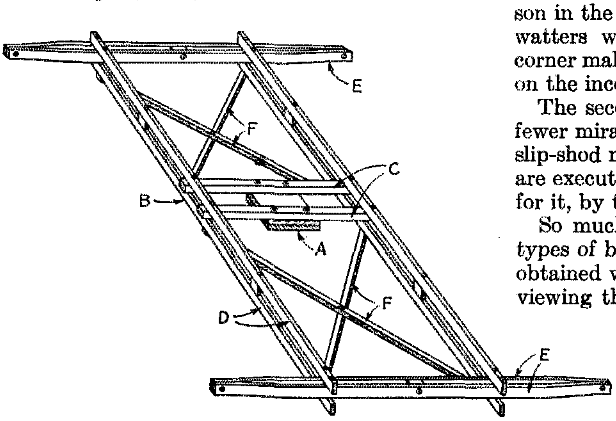
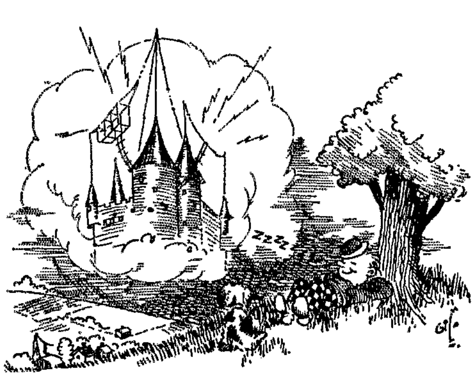


FIG. 3—MECHANICAL DETAILS OF THE SUPPORTING STRUCTURE

The construction is explained in the text. Note how additional rigidity is obtained by means of the bowing of the sections marked "E." Dimensions given in text.

watts input most of the time, but it can be run up to a kilowatt. Before the little rotary was put up, an attempt was made to cover the world by using three full-wave "8JK" beams, suitably oriented, and in the clear. These three antennas were eighty-five feet high. Never could the full power be pushed into one of them without having plenty of radiation from the other two. The little beam was put on top of a sixty-foot pole and since it was put in operation every contact that could be had with any of the others also could be made with the little one. Tests have been made, of course, with the other units both up and down. Full mechanical details of this beam, its matching stub and transmission line are given in Fig. 1. It is bi-directional, and for certain territories we believe it would be better to use a close-spaced half-wave uni-directional affair such as is shown in Fig. 2. But we are not considering the merits of any particular type of array; you can do as you please about that. Some serious consideration and more than a little experimental work has resulted in the construction of a good supporting structure, which may be used with almost any sort of array you may desire to use for either ten- or twenty-meter operation.

The job which W2AZ did in building his framework was so good and substantial that we decided that all our worries were over and we duplicated it, hook, line and sinker. We not only got a shock when the lumber and bolts set us back a few cents over five dollars, but our misery was practically complete when we found that the wooden structure, without the insulators or the antenna elements, weighed sixty-four pounds. We don't have all the room in the world, nor do we have a telephone pole. A three-by-three, poked in a corner by a chimney, is just about all we can get away with. So we had to do the job over again, making the changes shown in Fig. 3. The unit which resulted suits our situation very nicely. It cost very much less, weighs only twenty-eight pounds all assembled, and is rugged enough to be perfectly safe. In fact, with the center anchored, we have actually sat on all four of the outside corners, one at a time, without being able to bend the structure more than a fraction of an inch.



The finished unit is shown in another photograph. We stuck to the same form of center construction, as well as to the use of 2″ by 2″ oak main supporting members. Though we have not actually tried it, we are convinced that these could be reduced to 1″ x 2″, mounted edgewise, further cutting the weight without weakening the structure.

The light-weight final assembly is believed to be a better all-around job, so we will outline a few pointers in connection with its construction, in the hope that some of the time it took us to do the work will be saved those who may wish to copy it. It should be remembered that we are not advocating any particular type of beam, but are suggesting a particular type of framework, which will be found useful in connection with the making of almost any type of beam which the supporting structure can be made to hold. We illustrate but a few, just to give an idea of the versatility of the wooden framework and some new corrugated, copper-plated telescopic steel elements, which have just been developed for this sort of work.[6]

Getting right down to brass tacks, the following list of material is necessary for our own version of the framework which W2AZ built:

2 pieces of ¾″ plywood, 12″ x 12″. These should be perfectly square and are used together to form "A."
2 pieces of 2″ x 2″ x 36″ oak, main supporting members ("C"), free from knots.
2 lengths of redwood, cedar or white pine, suitably finished and free from knots, 16′ x 3″ by 1⅛″.
4 square head, 5/16″ x 4″ bolts, used to attach "A" to "B."
4¼″ x 5″ square-head bolts, used to join "C," "D" and "F" together, in the center.
4¼″ x 3″ square-head bolts, used for joining the outside extremities of "E," to provide the bowing.
2¼″ x ¾″ machine bolts, with suitable washers and nuts, used to join the centers of the units marked "F."
12¼″ x 4″ square-head bolts, used for joining all the other sections together.

All bolts should have a washer on each side. None of them should be taken up all the way before all the rest of the bolts have been put in place, and they should be taken up a little at a time and in regular rotation.

If the entire platform is measured properly, the hole centers on the units marked "F" of the W2DKJ assembly will measure 5 feet, 1¾ inches apart.

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[6] Made by Premax Products, Niagara Falls, N. Y., and to be placed on the amateur market in the near future.

for use as driver tubes for a Class-B modulator of appreciable power, and because of the fact that the tubes, with wide tolerance of load impedance, could be used with the Class-B driver transformer to plate modulate the 807 r.f. amplifier included in the r.f.-audio unit. With a maximum value of audio output exceeding 15 watts, and a maximum rated input power of approximately 40 watts for the 807 as modulated Class-C amplifier, the combination of 807 and 2A3 tubes makes an excellent 'phone transmitter of approximately 25 watts output.

Although a great amount of time and effort is involved in the construction of such units as described, the cost to the user is more than repaid in the operating satisfaction given by the flexibility and the assurance of proper operation of the completed assemblies.

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Reducing the thickness of the sections marked "C" to 1" x 2", will not change any of the other measurements, or the size of the bolts required, if the members are set up on edge. This will cut the weight down materially, without reducing the strength enough to be noticed. Unless this is done, the units "A" and "C" weigh thirteen pounds, while all the rest of the assembly, along with the necessary bolts, only weighs sixteen pounds. Further reduction in the weight of the central section may be secured by using redwood or pine instead of the oak for the "C" members, as was used by W2AZ and W2DKJ.

It will be observed that we have suggested two 16-foot lengths of 1⅛" x 3" redwood. That is a standard-size finished board. The two lengths are run into a rip saw, to produce four lengths each 1⅛" x 1⅛" and two lengths which will measure 1⅛" x ½" (approximate measurements, depending on the thickness of the rip saw).

The square lengths are then cut into four lengths of 9 and four lengths of 7 feet, which are to be used for the sections "D" and "E." The remaining flat pieces can be cut after the rest of the assembly is completed. They are used for the transverse braces, "F." The few little pieces which remain are the only waste.

There are so many different ways in which the platform may be mounted and so many different methods for rotation have already been described that there is little point in discussing them here. It is thought that what we have already written, along with the pictures and drawings, is all that is necessary for duplicating this structure.

How Would You Do It?

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eliminates a slight 'pinging' noticeable with some crystals. Incidentally, the relay must be of a type having low capacity between contacts. It should operate on low current; otherwise the relay circuit itself may be responsible for slight clicks in the immediate vicinity of the transmitter. With a low-current relay, a one-quarter-microfarad