A Rotary Spider-Web Loop Antenna With Reflector

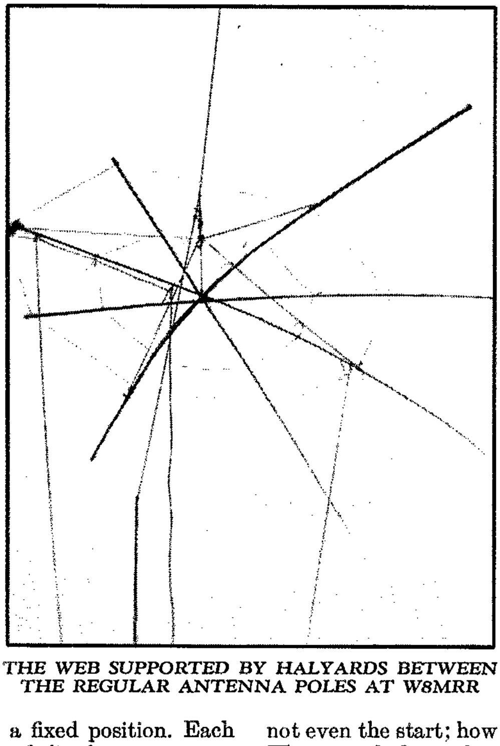
An Inexpensive Horizontal Array of Good Directivity

By Charles W. Lugar,* W8MRR

IT has not only been the desire of the writer to find a solution for the problem of present congestion of our allotted amateur bands but also find a means for hearing and working DX. Quite naturally the above sounds like a large order to undertake; but, nevertheless, it is a task which is growing in importance by virtue of the fact that our ranks continue to increase.

Briefly, let us state that more power does not solve the problem. Granted, our percentage of stations worked may increase in the face of QRM; but it is also granted that, as first one of us and then many add watts to the final, the conclusion is bedlam! The situation is certainly not improved by such a trend.

Where, then, can we start to find a solution? At least one trail seems worth following; namely, the antenna. Many are on the way and the results achieved to date are well worth additional study and experimentation. Let's pause a moment and size up the antenna situation from a general viewpoint. We can divide the various systems into two classes, generally speaking, from the standpoint of mechanical construction; those capable of mechanical change of their orientation at the will of the operator, and those maintained in a fixed position. Each class has its advantages and disadvantages over the other—gain, size, ease of construction, space required, labor, cost, frequency flexibility. All these factors should be given consideration if we are to design an antenna that can be utilized by the majority and that, consequently, will be a step forward in the solution of our problem. We may not all have a forty-acre field or even a complete kit of tools, not to mention the size of the proverbial pocket book. This latter sometimes supplies a certain amount of braking action to our enthusiasm.


THE WEB SUPPORTED BY HALYARDS BETWEEN THE REGULAR ANTENNA POLES AT W8MRR

In view of all the above, just where do we get off? It has been our experience not to get excited over working in any one particular direction. Rather, we like to communicate with the boys whether they be east, west, north, or south. Likewise, when we are carrying on a QSO to the east, for instance, we do not like competition from other directions. Therefore, in answering the above we decided that some form of rotary antenna with the greatest possible pick-up and transmission in one direction was desired, plus the fact that ease of construction and low cost were to be given every consideration.

All our thoughts and schemes seemed to be rather complicated affairs; lattice-work masts, electric rotating drive mechanisms, thrust bearings, remote control, and various designs of complicated arrays. All of these ideas were very fine and possibly of value—but not altogether necessary. At any rate, they can be added at any time if desired. But this was not even the start; how about the antenna itself? We noticed that others had obtained a gain in one direction by twisting a half-wave dipole in the form of a circle,[1] thereby getting with one stone the two birds, small space and good directivity. Then the idea took the form of a new question. How about adding a reflector to this

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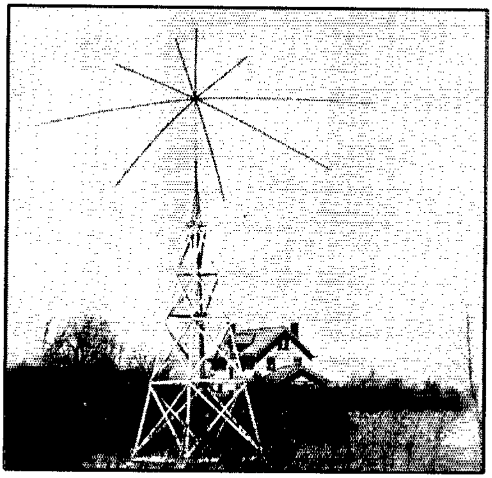
[1] J. L. Reinartz, "Half-Wave Loop Antennas," *QST*, Oct., 1937.



A RIGID TOWER EQUIPPED WITH A ROTATING MECHANISM SUPPORTS THE WEB ASSEMBLY AT W8MJM

design? From there we were off in a cloud of dust. (Although it happened to be wet at the time!) Copper tubing was a little heavy, as we had decided to utilize a couple of poles already in position. We would make a framework of bamboo and hoist it into place, as we would any other antenna, between said poles. Ordinary wire, No. 14 or No. 12 copper, seemed logical from this angle. However, we realized that a circle could not be formed with such material; therefore, the octagonal shape was decided on, since we could get this with five 20-foot bamboo or cane fishing poles.

After looking around we located the poles and proceeded to bring five of them home. They were laid out in the backyard and lashed together, as shown schematically in the accompanying diagram of Fig. 1. Next, a piece of string was made fast to the center or pole intersection and a length of 5 feet 8 inches was measured off on the string. Using this as a radius, each pole was marked this distance from the center. Next a length of 11 feet 6 inches was measured off and this was also marked off near each end of the double cross pole (A-A′) and the small ends of the other three center poles (B′-C′-D′). This distance finally became 11 feet 2 inches after some work with a signal strength meter.

Ordinary porcelain cleats or insulators were made fast to the poles, as suggested by the detail in Fig. 1, and the radiator and reflector wires were fastened to the other ends of the cleats. Airplane-type strain insulators, large size, can also be used here. A few feet of sash cord served for making a bridle and the entire array was secured to rope halyards from each of the two masts. It was then a simple matter to hoist it in place approximately one-half wave off ground. It is interesting to note that we did the hoisting in less than two hours after assembling the necessary materials—and most of them came from the junk box, at that.

By adjustment of the bridle ropes any tilt angle desired can be obtained. Two other ropes were attached, one toward the front and the other near the rear. By proper manipulation the array can then be rotated for orientation in any direction. Other schemes for rotation can undoubtedly be thought up that would be superior to this means. In fact, several such rotation designs have already been presented in *QST*.[2] The above method of rotation, although having distinct disadvantages, can be made to work and happens to be very inexpensive.

In Fig. 1, showing the schematic plan view of the array, A-A′ consists of two 20-foot bamboo

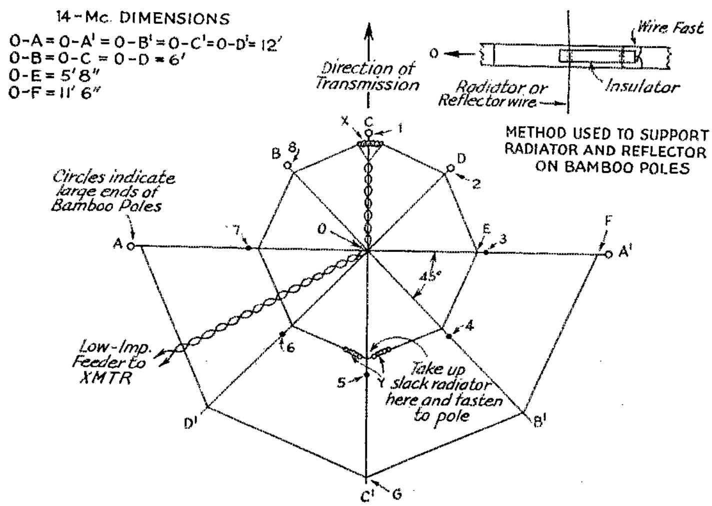


FIG. 1—SCHEMATIC PLAN OF THE ANTENNA AND REFLECTOR ASSEMBLY FOR 14-MC. OPERATION

fishing poles, so lapped that a total length of 24 feet is obtained, the poles being lashed together large ends out. B-B′, C-C′, and D-D′ are 20-foot single bamboo fishing poles with their small ends trimmed off slightly after the array has been as-

(Continued on page 90)

[2] M. P. Mims, "All-Around Signal Squirter," *QST*, Dec., 1935; F. G. Southworth, "Antenna Rotating Device," p. 39, *QST*, June, 1936; B. T. Simpson, "Square 'Signal Squirter,'" *QST*, Oct., 1937.

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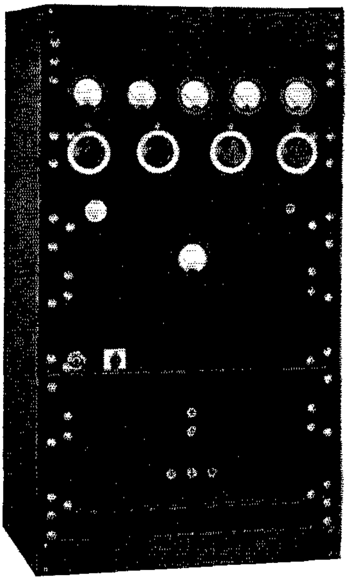

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A Rotary Spider-Web Loop Antenna with Reflector

(Continued from page 26)

sembled. All the poles are laid out on the ground as shown in Fig. 1 so that their included angles are 45 degrees and lengths O-B, O-C, and O-D are made 6 feet. Then lengths O-B′, O-C′, and O-D′ are trimmed to 12 feet (at the small ends of the poles, since these portions are rather weak). They are then lashed together at point "O" with the large ends of the poles at points A, B, C, D and A′.

Ordinary antenna insulators are used at "X" and "Y." Two insulators at point "Y" can be used to better advantage than a single insulator since this will provide a means for drawing up the radiator to make it taut after it is of the correct electrical length. At all points other than "X" and "Y" (a total of eleven) where either the radiator or reflector is secured to a point on any bamboo pole, the above-mentioned porcelain cleats or other insulators are used.

The distance from insulator "X" to point "G," at the center of reflector, is approximately one-quarter wave. The reflector is cut long and pruned for greatest current in the reflector at point "G" with the radiator excited. A small incandescent bulb (Xmas tree type) shunted across a few inches of the reflector at point "G" is a simple means for indication of maximum current at this point. Should you have a radio-frequency meter around the shack with appropriate scale, it can be used to advantage. The reflector length was found to be quite critical.

The spacing of the reflector and radiator should be set with a signal-strength meter if possible. Testing with a distant station is also all right, provided the receiving station has a meter of some kind for indication of signal input and the band is in a steady condition at the time of the tests. This latter, however, is practically impossible to attain. In tuning up be careful to make sure that the antenna is always at the same height because the effective height above the ground influences radiator and reflector lengths. In one instance here we found that the radiator had to be lengthened 7 inches when 4 feet off the ground whereas at 24-foot height it had to be this amount shorter. Remember that care in pruning is the difference between an antenna that goes places and one that is just another antenna.

As mentioned previously, the array can be suspended between two masts or poles by making a simple bridle of rope (similar to a kite bridle) attached to points 1, 2, 3, 4, 5, 6, 7, 8, and 0. We tried attaching the bridle to points 1, 2, 3, 4 and 0, but prefer the former because it prevents sag. Shortening up on the forward ropes permits adjustment of the tilt angle. A separate rope could be run to the operating room to adjust the tilt angle if preferred. This could be accomplished by running a rope through a small pulley which is secured to a stick driven in the ground directly beneath the antenna pole intersection. We have

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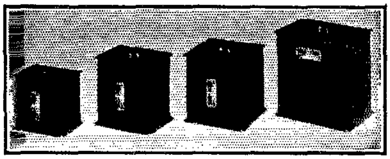

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not attempted this, but believe it could be made to work.

A word about the tilt angle. A fixed tilt angle of 15 to 20 degrees, determined experimentally here at this location, seems to be about right. On tests with stations in this country we found that a tilt angle of approximately 20 degrees increased the signal strength nearly 33 percent as compared to either a tilt angle of 0 degrees or 45 degrees. As the tilt angle approached 45 degrees the gain equaled that which was obtained in the horizontal position. The radiation to the rear decreased at a 20-degree tilt angle and increased to half the forward radiation at both 0 and 45 degrees. This made for a front-to-back gain in the array of approximately 8 db at the distant receiving station.

In Fig. 2 a field-strength diagram is given for the array. This was taken by setting up a field strength meter 300 feet distant from the antenna and then rotating the array. The curve is plotted for db values above the minimum observed. The pattern is unbelievably sharp for such a simple array. Often, after hearing some station, we rotate the beam until we get maximum signal strength on the receiver. You really get a kick hearing a weak DX signal build up until it is above the noise. Also, it is amusing how it discriminates against signals that would otherwise make a QSO impossible.

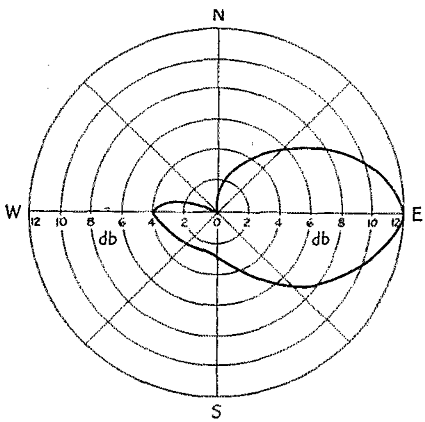
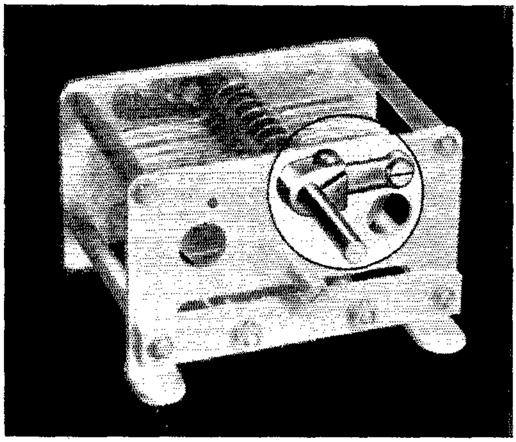


FIG. 2—RADIATION PATTERN PLOTTED IN DB ABOVE MINIMUM FIELD STRENGTH IN N.W. DIRECTION

The measurements were made with the web 24 feet above ground and tilted 20 degrees above horizontal in the forward direction.

In addition to having a lobe right off the front there are also lobes off the top and bottom. Working at a height of one-half wavelength above ground seems to assist in cancelling these two lobes. However, they are not entirely lost and they undoubtedly help from a high-angle radiation standpoint. It seems to work out in practice that during the daylight hours when skip is comparatively close in, possibly only 1 to 2 S-points difference in signal strength may be noted with rotation of the array. However, at other times, when the skip distance is much greater, a differ-



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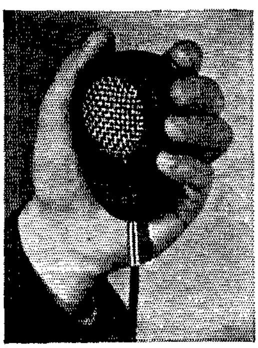

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ence of as high as 6 S-points have been noted after rotating the array.

W8MJM has had one up for approximately five months and claims much for it, especially from the receiving angle. W9CIH, Bob Palmer at Ashland, Wis., has also had one up for quite some time. He has been reported "S9 plus" in Manila, P. I., at noon, C.S.T., and says that to date he never has had less than S7 from VK's. The snapshot of W8MJM's installation shows it to be more of the conventional type of rotary set up. Bob has his on top of the house.

In conclusion, we can state that the rotary web array has far surpassed the general run of fixed type antennas used at this location. It has been in operation since March 20, 1937, and has given excellent service since its installation. QRM is decreased to a remarkable extent when using the array for a receiving antenna; and the system also has been a revelation in hearing and working DX.

. . . 78° North, 72° West

(Continued from page 31)

signals have been heard on the 3.5- or 8-Mc. bands. On 28 Mc., during the first part of October, I did hear a few weak signals. However, not much time was spent there; merely listening just to see what conditions were like. I hope we shall be able to contact all of you boys who want to get another country or zone that lies up here for you. Your messages, relays and contacts are all greatly appreciated by Captain C. J. MacGregor, by the crew and me. We will be frozen in here at Reindeer Point, near Etah, Greenland at least until the middle of next July—then we leave as soon as the ice breaks up and we can get out.

The MacGregor Expedition Transmitter

THE r.f. line-up consists of an RK-25 crystal oscillator capacity coupled to an RK-39 buffer-doubler. This stage is link-coupled to a pair of RK-20's which furnish ample power to drive the final, consisting of two HK-354's running at 2000 volts with an input of 500 watts. When this layout was decided upon it was borne in mind that it would be possible to use the RK-20's as the final should reduced-power operation become desirable.

To guard against burning out irreplaceable parts, an underload and an overload relay were incorporated in the power supply of the final.

The audio-frequency end of the transmitter was built to operate from a crystal microphone. The speech equipment is divided into two sections, a pre-amplifier and main amplifier, so designed that the frequency response characteristic and hum level are satisfactory for re-broadcast use. The pre-amplifier is resistance coupled up to the output, and is very compact. Two gain controls are provided to take care of the different levels of the microphones used. The volume con-