Concentrated Directional Antennas for Transmission and Reception

Rotatable Loops and Antenna-Reflector Systems of Reduced Dimensions

ALL the "angles" pertaining to directional antenna systems are not just those we usually talk about. Besides angle of concentration in the vertical or horizontal plane, angle of rotation, angle of the wires, there is also the all-important "angle" of, "how much space?" Rhombics and multiple arrays of conventional form give high gains—but even for the 14-Mc. band they take considerably more yardage than most of us have available. Therefore, concentrated directional systems which are more readily fitted into the usual back yard have a distinct appeal from the space "angle". While they may not give such tremendous power gains, as compared to a simple halfwave dipole, they can give front-to-back ratios which noticeably improve the signal-interference ratio for the owner in reception and for the other fellow in transmission. By forming half-wave units into different shapes, thereby reducing the over-all dimensions, John Reinartz has achieved several different types of compact directional systems. In the following articles, W1QP outlines the electrical design and performance of half-wave loops, and Dr. Simpson describes the folded-end antenna-reflector system constructed for his station on suggestions from W1QP.

Half-Wave Loop Antennas

By John L. Reinartz,* W1QP

AN UNUSUAL type of loop antenna for both transmitting and receiving has been in use at W1QP for some time and has been found particularly useful on the higher frequencies. At 2½, 5, 10 and 20 meters, this antenna has shown itself well suited for amateur use, especially where room is at a premium. Even attic space is sufficient for its erection. When mounted out of doors, it compares very favorably with the usual type of half-wave "straight" antenna in all respects and has the advantages of a high degree of directivity and polarization sensibility. An additional advantage is that this antenna can be used for direction finding. Feeding the antenna is no problem because feeder radiation or pickup is negligibly small and because symmetrical loading of the feeder line is accomplished as a matter of course. Because the antenna is simple, construction difficulties do not present themselves in any marked degree and are not beyond the facilities of the amateur. In its simplest form, the antenna can be erected in less than 30 minutes.

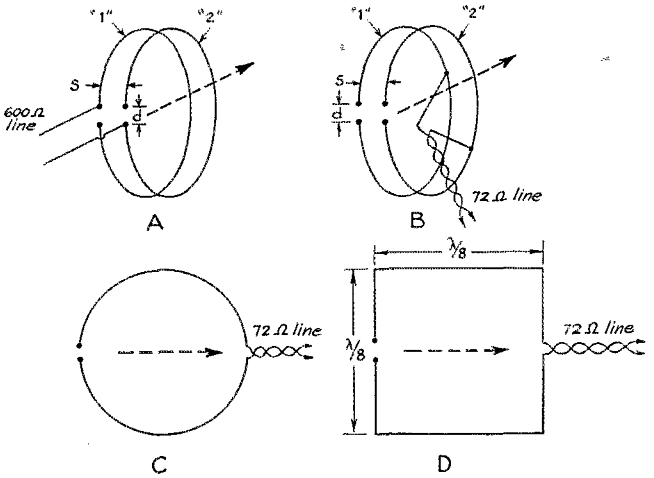

FIG. 1—DOUBLE-CIRCLE, SINGLE-CIRCLE AND SQUARE HALF-WAVE LOOPS WITH DIFFERENT FEEDER CONNECTIONS

The spacings "d" and "s" are described in the text. The arrows indicate the direction of maximum concentration in transmission.

The basic idea of the antenna centers about a half-wave length antenna conductor, preferably of aluminum or copper tubing, bent into a circle. In its preferred form, as shown in Fig. 1A, the antenna is made up of two such circles spaced a few inches apart by means of supports of insulating material (which may be wood that has been soaked in oil or paraffin). Of course the circles do not quite close since that would short-circuit the antenna and render it useless. The recommended opening in the circle, *d*, is 0.2 inch per meter; thus for 20 meters, the opening is 4 inches. The recommended spacing between the two circles, *s*, is 1 inch per meter; for 20 meters, the spacing is 20 inches. The circles are so mounted that the openings coincide. Because the antenna has a directional front-to-back ratio which in practice

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amounts to a power ratio of 4 or approximately 6 db, it is important to be able to change the direction in which the antenna points. A gain in signal is obtained in the direction of the current loop side of the antenna; a reduction in signal is

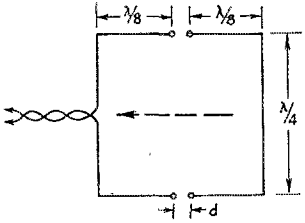
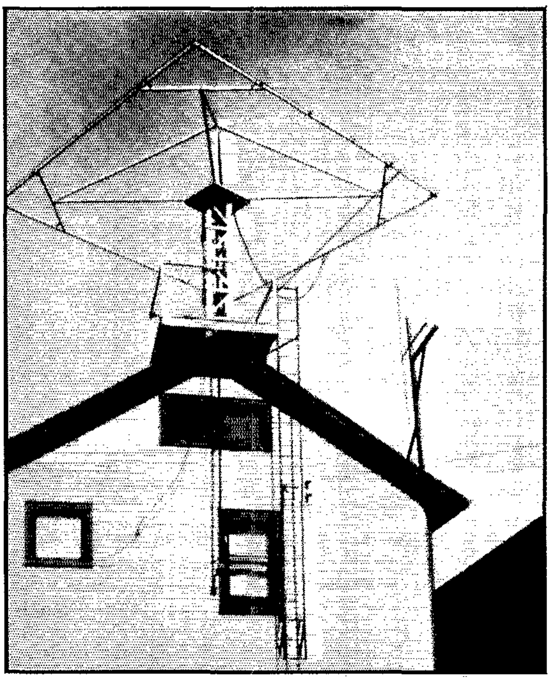


FIG. 2—THE SQUARE RADIATOR-REFLECTOR SYSTEM IS MADE COMPACT BY BENDING THE END EIGHTH-WAVE SECTIONS OF THE WIRES, MAKING THE DIMENSIONS A QUARTER-WAVE ON EACH SIDE

experienced in the direction of the voltage loop or open ends. This statement holds good for both reception and transmission. Therefore, when the antenna is mounted in a vertical plane, for rotation about a line in the plane of the loop, the open end is placed at "3 o'clock" or at "9 o'clock". When the antenna is mounted in a horizontal plane, the direction of transmission and reception is given by an arrow starting from the open end and drawn across the middle or current loop. The field strength gain in the forward direction, it should be mentioned, is about 28% as compared to a straight half-wave dipole.

The feeders can be connected to the antenna in a number of ways, the best way depending on the type of feeder. The spaced type of feeder is recommended for 28 Mc. and higher frequencies in order that the transmission losses may be kept at a minimum. For 14 Mc. it is perfectly feasible to use any of the good low-impedance or 72-ohm lines that are on the market. When a tuned, spaced line is used, the connections are to opposite ends of the circles, one on the Number 1 and the other on Number 2 circle, across the diagonal. This means that each feeder is symmetrically loaded to the antenna, a condition which is hard to obtain with a normal end-fed half-wave antenna, such as a Zepp.



THE QUARTER-WAVE SQUARE "SIGNAL SQUIRTER" AT W8CPC

It is rotatable to all points of the compass by gearing to a directionally calibrated control wheel in the operating room.

When a low-impedance, or 72-ohm, feeder line is used, it is connected in a similar manner but at the current loop, one feeder wire going to one circle a little off from the middle of the antenna and the other feeder going to the other circle a little off from the middle of the antenna in the opposite direction. The optimum distance between the connection of the feeders and halfway point on the antenna depends on the impedance value of the feeders and may be from 0.1 inch per meter to 0.5 inch per meter of the fundamental wavelength. The optimum distance can be determined by the fact that the load drawn by the antenna is greatest when the feeders are connected at the optimum distance. Another indication of proper adjustment is that, with this adjustment, no change in tuning results when the antenna coupling is removed.

A modification of the double-circle loop antenna consists of but one circle or one square, mounted either vertically or horizontally, as shown in Figs. 1C and 1D. Again, a half-wave length of wire is formed into a square, and is left open by the amount, *d*, previously mentioned. Then the point opposite the opening is cut and a 72-ohm feeder line is connected into this cut, exactly as would be done in the case of a center-fed half-wave antenna. The difference between the square or circular antenna and the center-fed half-wave straight antenna is that the square or circular antenna is unidirectional rather than bidirectional. Both the square and circular antenna will give remarkable results, even when mounted in an attic. Both of them are easily made steerable. The circular antenna can be mounted in a horizontal plane and suspended with waxed string from the attic rafters. With this arrangement, the antenna can be pointed in any desired direction. The square antenna can be constructed with an insulator inserted in the middle of each side of the square. With this arrangement, the antenna can be aimed, electrically, in any one of four directions by shorting out two opposite insulators.

The feeder also may be a single wire connected half-way between the open end and the current loop. This feeder gives the same general results as those obtained with the spaced feeders and the 72-ohm line. Some confusion may result when it is found that the receiving station obtains the best signal from the direction opposite to that in which the antenna is pointing. This is one of the phenomena apparently due to the polarization effects of the antenna. When mounted in a vertical position the antenna transmits a vertically polarized wave, and receives best a wave which is vertically polarized. When the antenna is mounted in a horizontal plane, the transmitted signal is horizontally polarized and a signal horizontally polarized is received with maximum strength. When the directivity of the antenna appears to be changed 180 degrees from the normal position, it is found that the transmitting station antenna is radiating a vertically polarized wave. The question of whether the antenna should be mounted with the plane of the loop vertical or horizontal is determined by the transmission requirements and the frequency to be used.

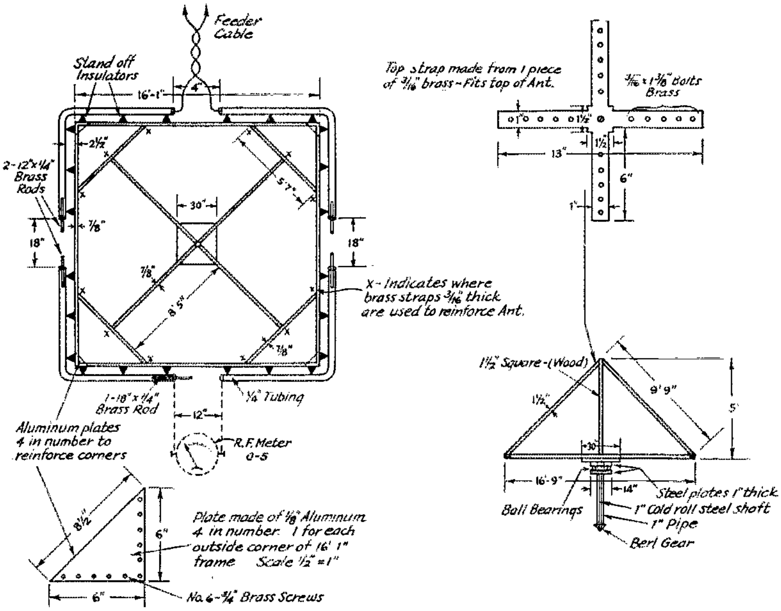


FIG. 3—CONSTRUCTIONAL DETAILS OF THE ANTENNA ASSEMBLY AT W8CPC

The diameter of the copper tubing is drawn to enlarged scale for clarity.

A Square "Signal Squirter" for 14 Mc.

By Burton T. Simpson, W8CPC**

THE idea for this antenna was suggested by John Reinartz. Upon the theory that the radiation from a half-wave antenna comes largely from the middle quarter-wave portion, it is argued that not much energy should be wasted by turning back each end. By doing this much space would be saved. To make the radiation unidirectional, a reflector was constructed on the same principle, thus forming a square. The schematic of this antenna system is given in Fig. 2, while constructional details are suggested in Figs. 3 and 4.

To form the frame, four lengths of fir wood, the type of wood used in making ladders, 16 feet 1 inch long by 1½ by 1⅛ inches, were formed into a square. A center block 30 inches square by 1⅛ inches thick is placed in the center. Across the corners are braces of the same material. From the corner braces to the center block are four more braces from the same material. In the center of the block a post 5 feet long by 1½ inches square is erected and four braces from the top of this to the corner braces are placed. You now have the main structure for the antenna which is 16 feet 1 inch square.

Four lengths of copper tubing 15 feet by ¼ inch are used for the antenna radiator and reflector. Starting at the radiator side, two stand off insulators 2½ inches long are placed exactly 4 inches apart. The ends of the 2 pieces of copper tubing are flattened and a hole placed in them to fit over the 2 insulators. From these ends Bassett cable is fastened and runs to the tank coil of the transmitter where it is link-coupled. Insulators are placed at intervals along the front and sides to accommodate the rest of the copper tubing. However, at the side ends the copper tubing must not be flattened because the final tuning is done by the insertion of brass rods in the open ends. It will be found that about 7 feet will be turned on each end. Turning the ends of the tubing

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shortens the calculated length of the antenna. This one happens to be 31 feet long.

Beginning at the reflector side of the antenna, two stand-off insulators are placed about 12 inches apart and the other two lengths of copper

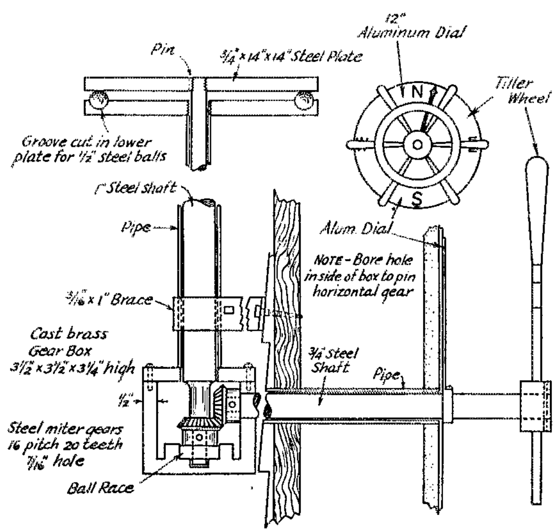

FIG. 4—DETAILS OF THE MECHANICAL SYSTEM USED TO ROTATE THE W8CPC ANTENNA

tubing are fastened to these by a strap. Then, with the required number of stand-off insulators, this is extended the length of the back and bent forward at the corners. With the exception of the 2 front portions which constitute the center of the antenna, the rest of the copper tubing must be fastened to the stand-off insulators by straps. It is important to have the distance between the antenna and reflector exactly 16 feet 6 inches.

It is necessary to have 5 lengths of brass rod to fit snugly into the copper tubing for tuning purposes. Four are inserted in the tubing on the sides; the fifth must be longer than the others to close the gap in the reflector after the meter inserted for tuning is removed.

Underneath the center square wooden block is a steel plate 14 inches square by 1 inch thick. This is bolted to the block of wood and has a groove for ball bearings. At the center of this is screwed a 1-inch steel rod to rotate the antenna. The steel plate fits exactly on the top of a similar steel block fastened to a 7-foot tower which rests on a platform built on the top of the house. The bottom of the steel rod fits in a gear box which is connected to a similar steel rod entering the radio room. On the end of this is a wheel backed by a brass plate showing the points of the compass. Details of the mechanism are given in Fig. 4.

TUNING UP PROCEDURE

In the open space in the reflector the r.f. meter is connected by short leads, and the Bassett cable link is inserted in the center of the tank coil of the transmitter. The transmitter is now turned on and the brass rods in the ends of the copper tubing are pushed in or out until the highest reading of final amplifier plate current is obtained. Then the brass rods in the ends of the reflector are manipulated for the highest reading in the r.f. meter. This will cause the final amplifier milliammeter to read lower. Again tune the antenna for highest final input, which will cause a decrease in the reflector r.f. reading. Retune the reflector in the same manner for maximum reading of the r.f. meter. This is repeated until both meters give the highest reading. Now tape the brass rods at the sides, remove the r.f. meter and close the reflector gap with its brass rod, tape it — and the job is completed.

At W8CPC this antenna works very well. In a typical instance, with the "squirter" pointed toward England, G5ML gave an "S9 +" report. With the antenna pointed in the opposite direction, he gave "S2". By using a relay in the cable circuit this antenna also acts as an excellent receiving antenna with quick change-over.

More on PITC

ABOUT the only thing that will stop a landslide is another landslide. We have reference to the announcement on page 56 of the September issue of *QST* wherein it was stated that steps were being taken by A.R.R.L. to arrange a fund for providing modern radio gear for remote Pitcairn Island. This resulted from the considerable number of unsolicited contributions received from readers of the original PITC article in the August issue.

But it seems that not only did individual readers have this idea—a group of manufacturers did, likewise. These manufacturers went ahead and lined up a complete station layout, including a Wincharger for charging the storage battery which was to serve as the primary power basis. In view of this effort, which by the time we learned of it had already progressed to a point where it could not readily be recalled, A.R.R.L. is abandoning its plans, has returned the contributions.

Right now we don't know just what the outcome will be. The islanders have as yet had no opportunity to express themselves on the subject. We don't know what their desires are; it may be that they want only 600-meter stuff, or it may be that Andrew Young can be persuaded to turn ham. We don't even know what the British government will have to say about it. But these things will be determined, and the story will, we hope, eventually be told in *QST*. Until then, thanks, gang! Your hearts are in the right place!