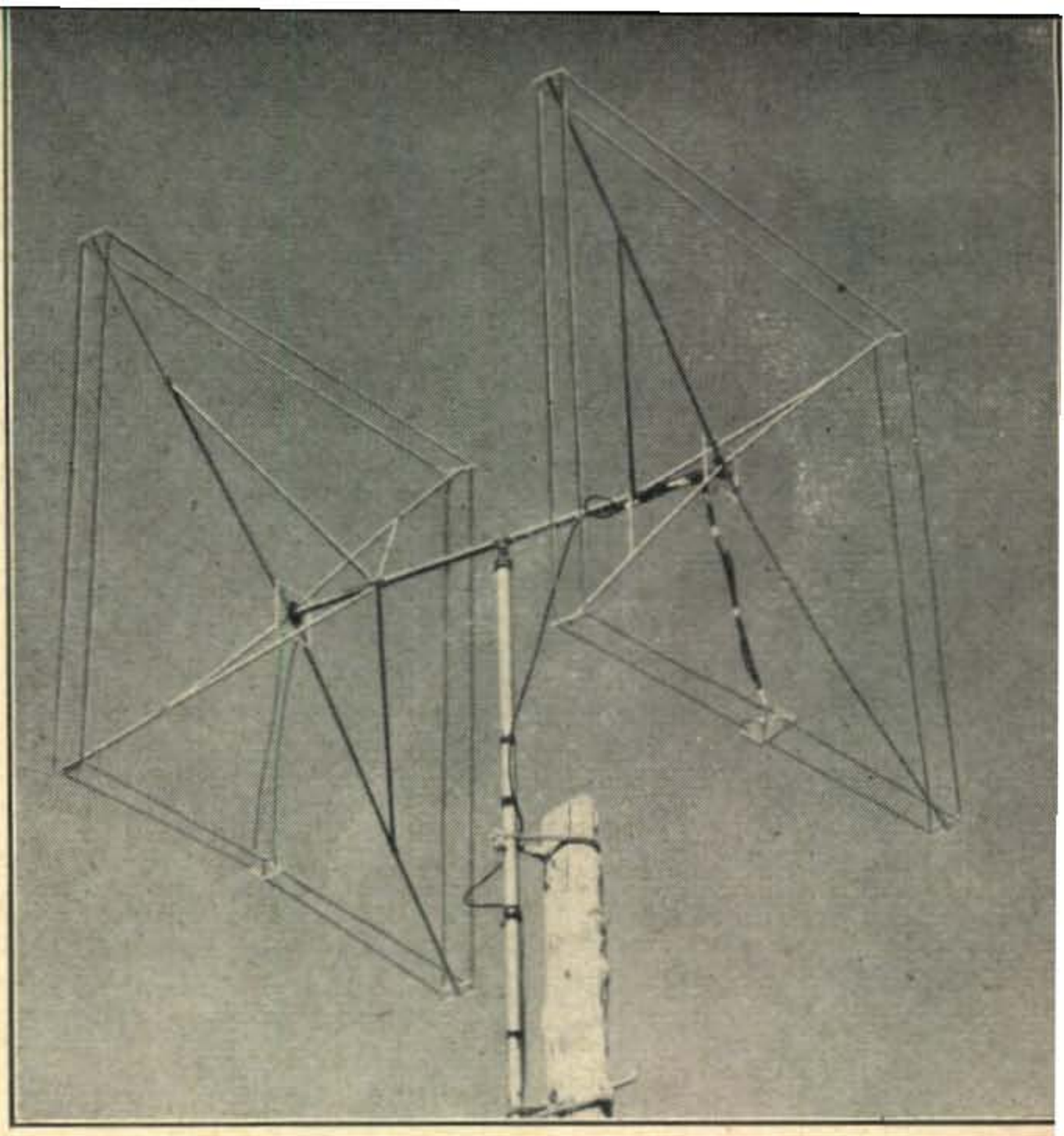


The square quad at W5NRP, mounted on a rotable steel pipe bracketed to a telephone pole. The coax feeder is lashed to the boom and then runs down the vertical support pipe. The one brace that is missing from the lower part of the radiator element was the only damage inflicted by three severe wind storms, one of 100 mph velocity. Directivity is along the line of the boom, from reflector toward radiator.

RAY HOFFMAN, W5NRP*
and
A. DAVID MIDDELTON, W5CA*

Constructing the CUBICAL QUAD

The most conclusive fact about the quad is that users have been getting excellent results.

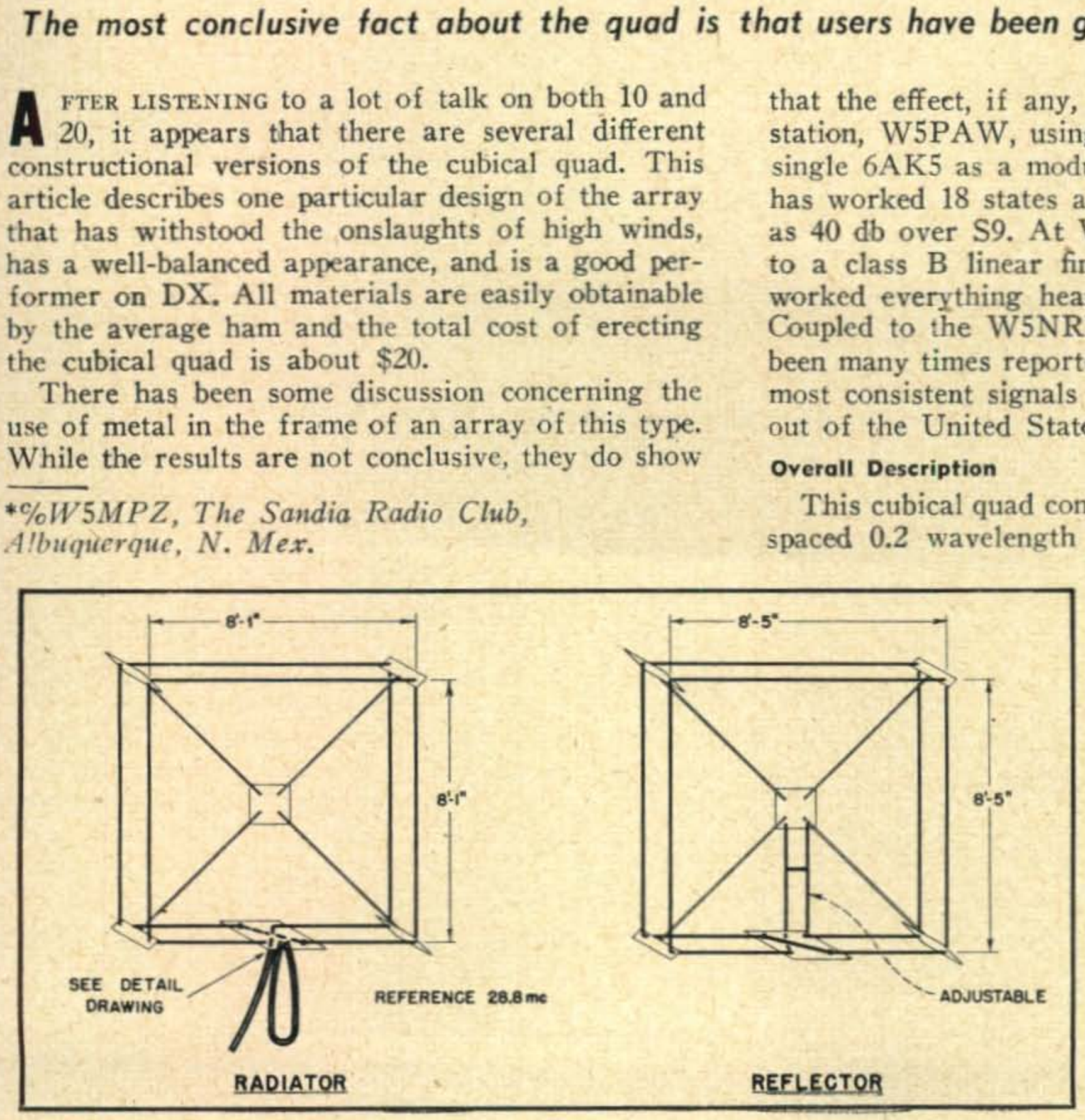
AFTER LISTENING to a lot of talk on both 10 and 20, it appears that there are several different constructional versions of the cubical quad. This article describes one particular design of the array that has withstood the onslaughts of high winds, has a well-balanced appearance, and is a good performer on DX. All materials are easily obtainable by the average ham and the total cost of erecting the cubical quad is about $20.

There has been some discussion concerning the use of metal in the frame of an array of this type. While the results are not conclusive, they do show that the effect, if any, is not detrimental. A local station, W5PAW, using only 2½ watts input to a single 6AK5 as a modulated doubler on 10 meters has worked 18 states and received reports as high as 40 db over S9. At W5NRP, running 900 watts to a class B linear final amplifier, the quad has worked everything heard with very good reports. Coupled to the W5NRP SSSC transmitter it has been many times reported as one of the loudest and most consistent signals from this area, both in and out of the United States.

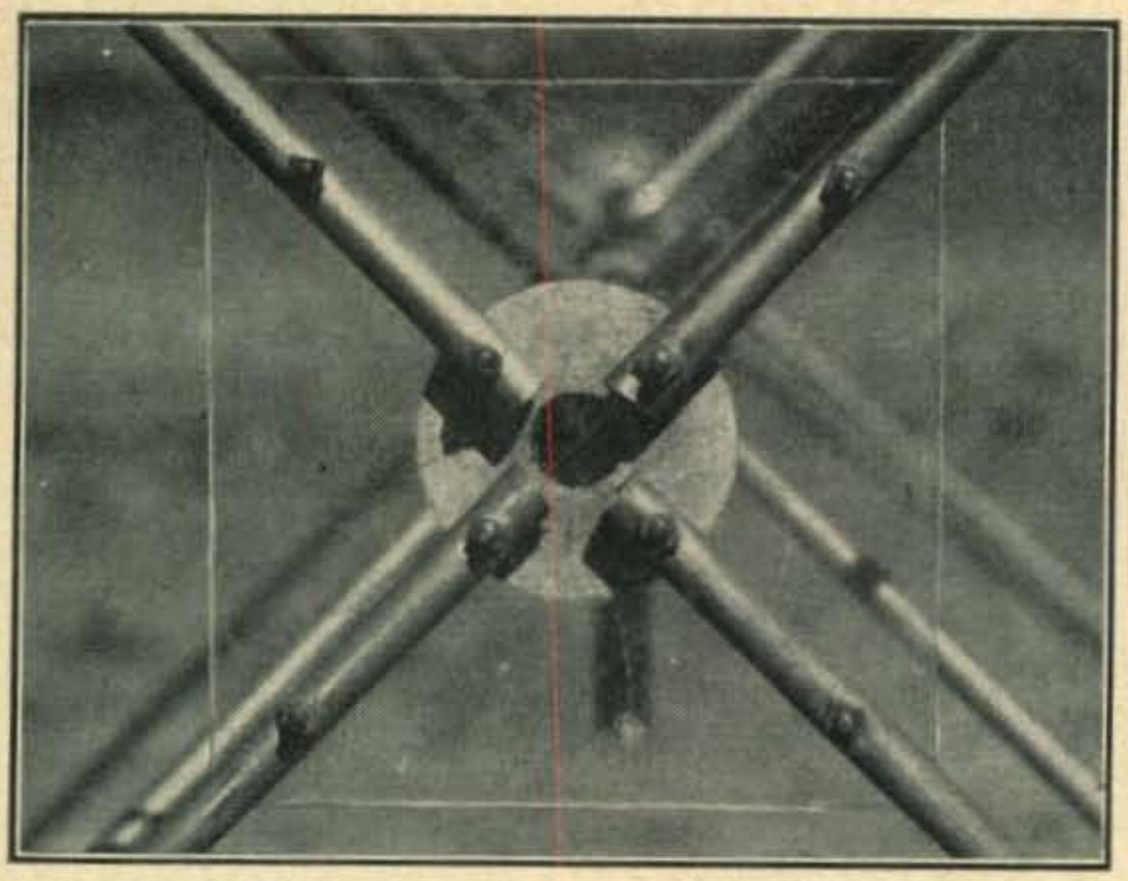
%W5MPZ, The Sandia Radio Club, Albuquerque, N. Mex.

Overall Description

This cubical quad consists of two square elements spaced 0.2 wavelength apart. Both elements con-



Simplified diagram of the cubical quad radiator and reflector.



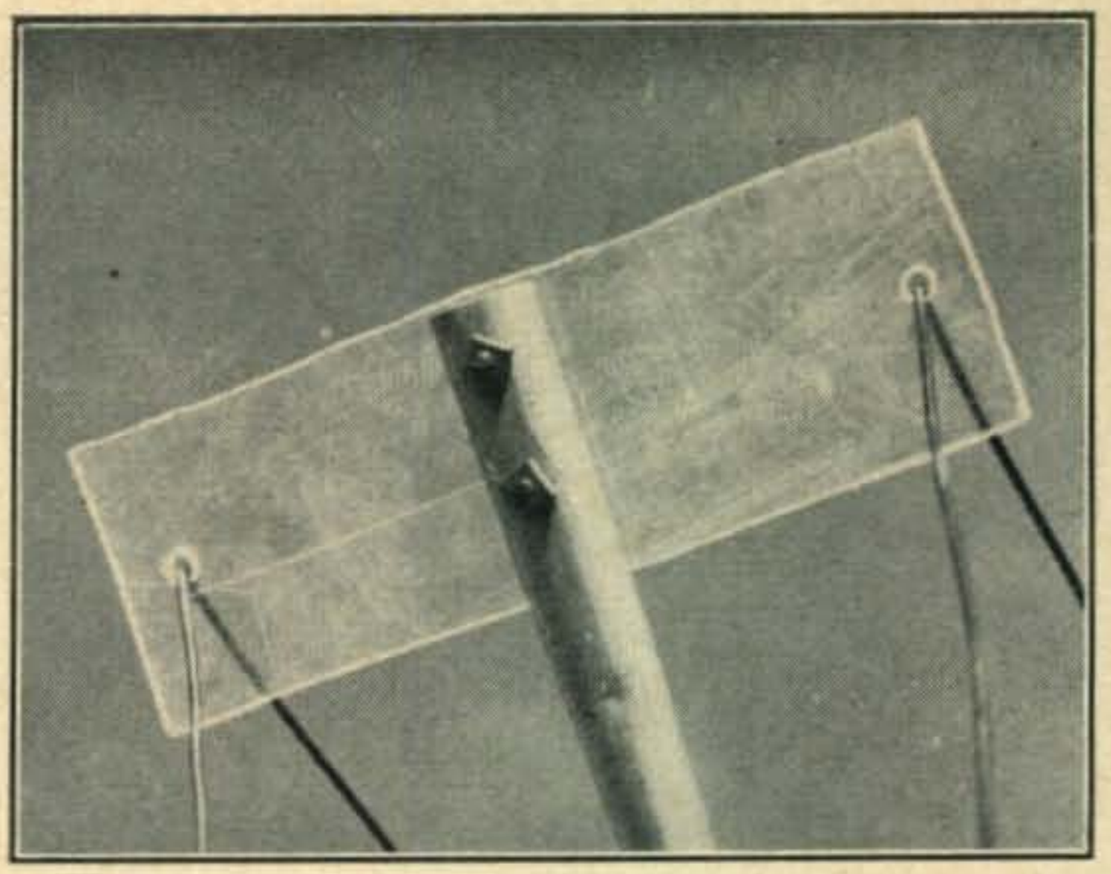


Fig. 1 (left). End on view of the center hub supporting the four arms of the radiator. The pipe flange was centered and the arms run out on diagonals to the corners of the nine inch square piece of Lucite. Fig. 2 (right). View of one of the Lucite spreaders—eight are required. After cutting off the arm to the correct length, the end is slightly flattened and two holes drilled to attach the spreader. The bolts are pulled up tight, cut off and flattened to prevent them from loosening.

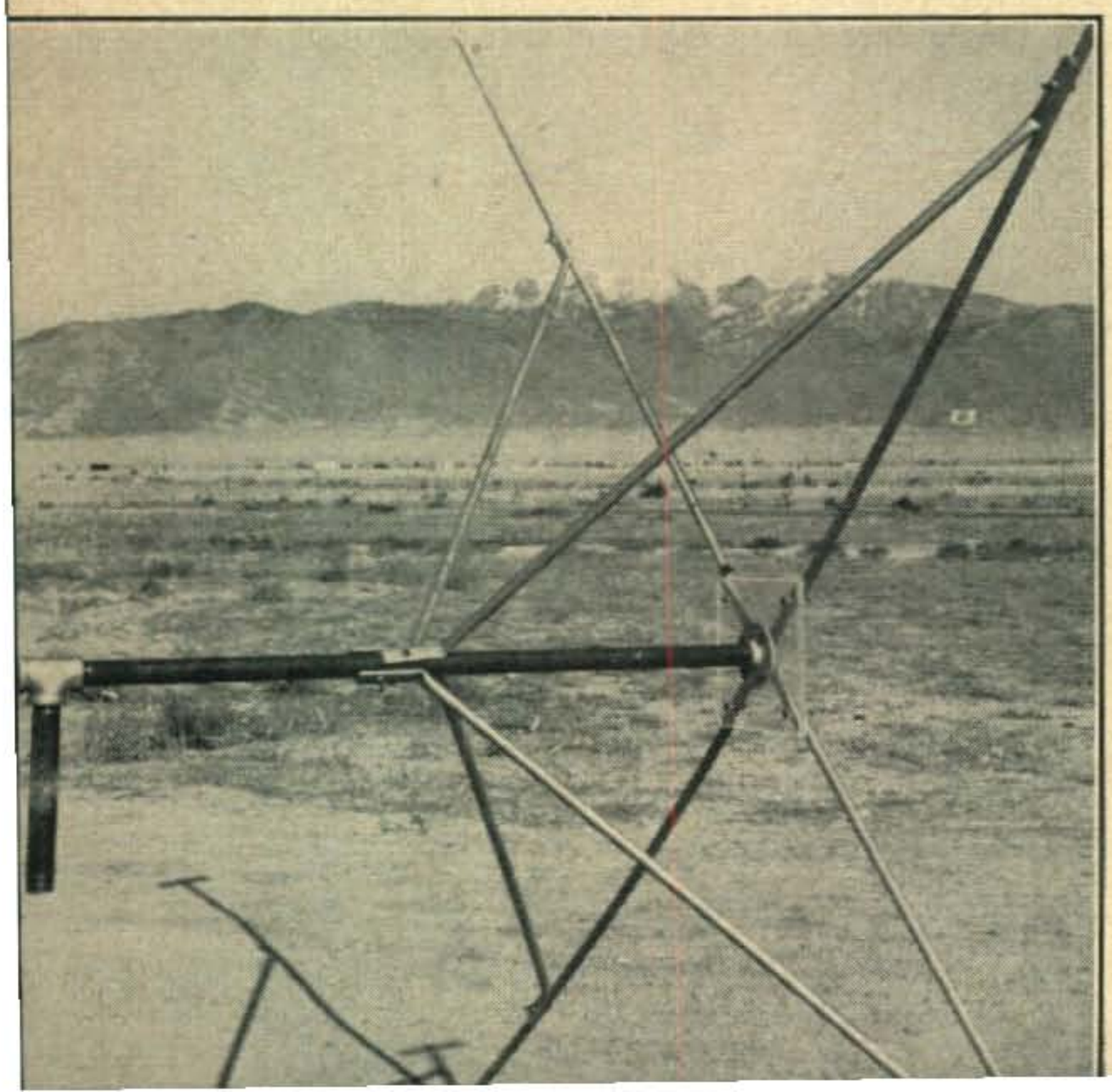
sist of two turns of wire, spaced 5½ inches apart with the cross-over point in the middle of the lower side of the square. The impedance at the feed point is the result of a rather complex set of conditions, but with the wire size and spacing used in this array it will be about 200 to 300 ohms. Since it was highly desirable that we use RG8U coax line and maintain balance, a phase inverter type of impedance transformer matches the coax line to the quad radiator.[1] This transformer is simply an extra length of coax about eleven and one half feet long. How to determine the exact length is shown in *Fig. 5*. The reflector is tuned by a stub, permanently mounted inside the loop. Tuning up is very simple and is described later in the text.

Each of the two elements is supported on a spider made of four pieces of thin-walled conduit. These are mounted on a center hub like spokes in a wheel. Insulating end pieces are attached to the spokes and support the wire making up the element. The two hubs are fastened to a single boom, which is in turn fastened by a tee to the supporting vertical pipe.

All of the highly desirable performance characteristics attributed to the cubical quad were noted. The front-to-back ratio is of the order of 30 db. The front-to-side ratios are much greater and are between 50 and 70 db. The forward gain over a dipole is about 10 db and the apparent vertical angle of radiations, for the height used, of the lowest major lobe maximizes about 10°. The frequency response is ±250 kc.[2]

1 H. M. Bach, Jr., "The Trombone T," CQ, March and April, 1947.

Fig. 3. Braces for each of the arms are cut from extra four foot lengths of conduit. The ends are flattened and one bolt attaches the brace to either the arm or the boom. The boom is cut from one inch pipe.



Construction

This quad is most easily constructed in sections and assembled later. The end plates shown in *Fig. 1* were the first items to be made. These are two 9-inch squares of plywood, wood, lucite or metal according to the builder's preference. Draw diagonals on the end pieces, then lay the pipe flange on the piece so that the four holes in the flange cross the diagonals. Mark, center punch and drill these holes in the end piece. Drill four more holes, one on each diagonal, one inch or so from the end. Make sure that these holes just clear the bolts that will be used. The arms are the next items—eight standard 10-foot lengths of thin-walled conduit are needed. The spider is assembled before cutting the arms to length.

First, punch and drill a hole in each arm about one inch from the end. Take four of the arms, an end plate and a pipe flange, and run 1½-inch bolts through each hole in the flange, end plate and arm. This will make a large X shaped frame with four

2 This is probably due to the use of the half-wave phase inverting transformer which exhibits optimum characteristics over a relatively small frequency range. A somewhat broader frequency response might result with the use of symmetrical transmission lines. —Ed.

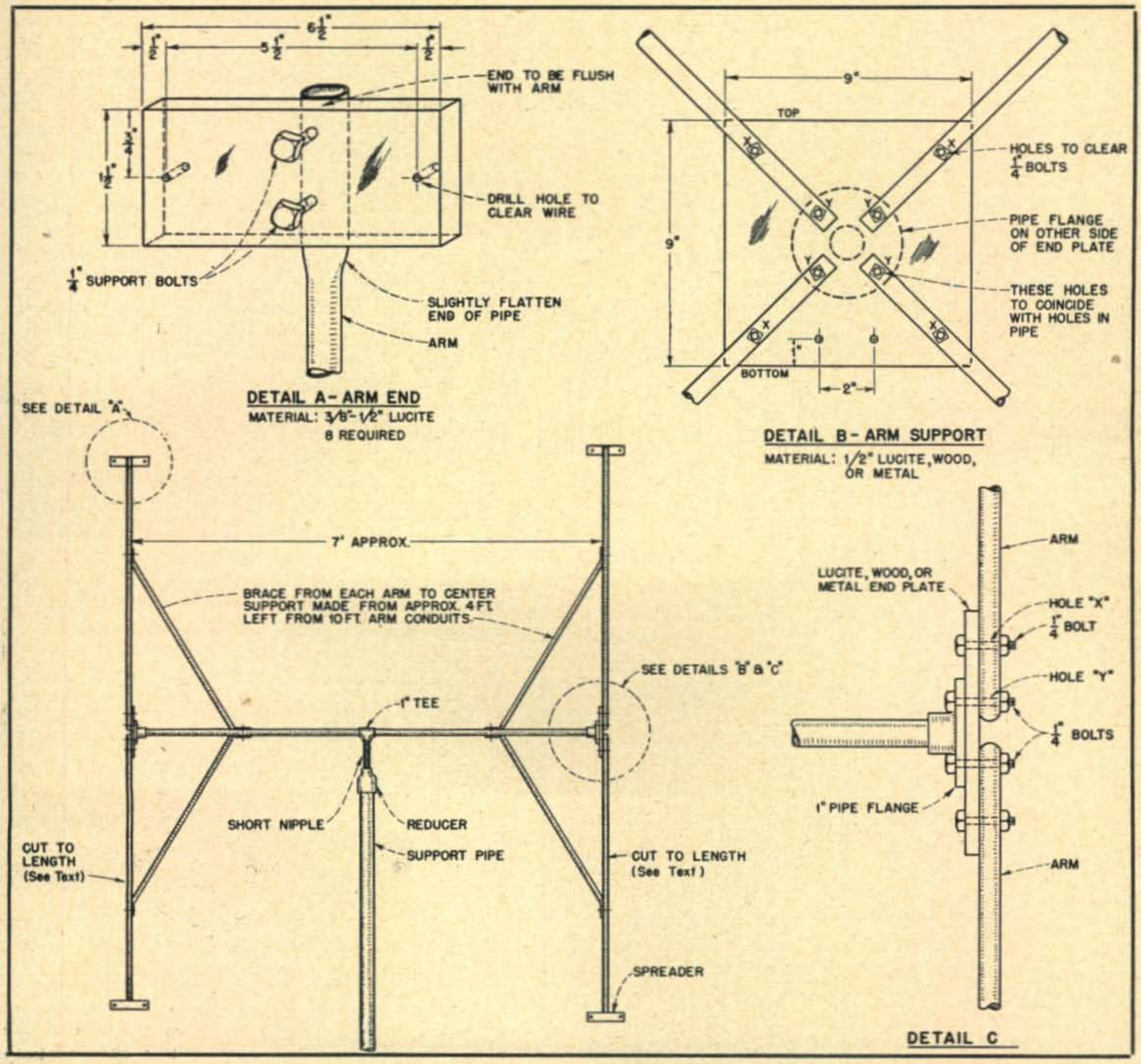
arms 10-feet long. Line up the arm with the diagonal line on the end piece and drill through the other hole and through the arm. Put a bolt through and then assemble the other X frame in the same fashion.

For a frequency of 28.8 mc the arms of the radiating element should be 70 inches from the center of the pipe flange to the end. The reflector arms are 72¼ inches from center to end. This length should be measured out on each arm, then remove the arm and cut off. It might also be best to mark the position of each arm on the end piece so that the pieces may be easily reassembled.

The spreaders are next prepared. These are shown in *Fig. 2.* We used Lucite ⅜-inch stock, 6½ x 1½-inches for the spreaders. Eight are needed—four for the radiator and four for the reflector. Holes for the #12 copper-clad wire are drilled ½-inch from each end. The holes for mounting the spreaders to the arms are then drilled 3¼-inches from either end. Remember that these blocks are

BILL OF MATERIAL

Quantity	Specifications
2 Booms	1" pipe, 3' 4" long, threaded ends
8 Arms	10' lengths of electrical conduit
2 End pieces	1" floor flanges
1 Boom support	tee fitting, 1" each way
1 Support	nipple, "one by short" (plumbers supply)
8 Spreaders	Lucite, 6½" x 1¼" x ⅜"
2 End pieces	Lucite, 9" x 9" x ½"
2 Cross-over pieces	Lucite, 6½" x 4" x ⅜"
16 Spreader bolts	1¼" x 1/4" bolts with nuts, lock washers
16 End piece bolts	1½" x ¼" bolts with nuts, lock washers
1 Support coupling	reducer coupling, 1" to support pipe size
140' #12 or #14 copper or copper-clad steel wire.	



Construction details of the cubical quad. Note that it is mounted in a "square" position.

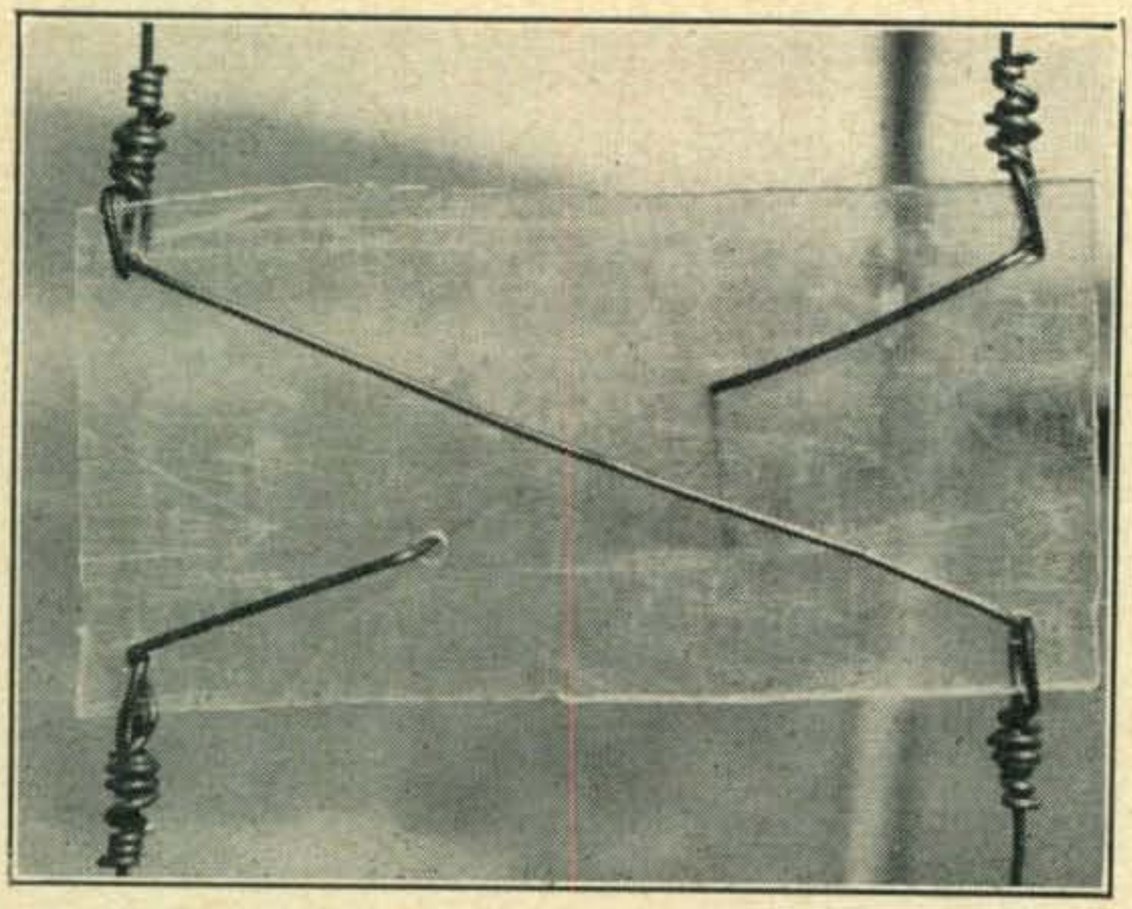


Fig. 4. One of the required two cross-over plates. Both loops are independent and are tightened down at this point. A short piece of wire is then used for the cross-over of one loop to the other. On the radiator, the broken cross-over lead goes to the coax feed. On the reflector it serves as the 2" spacer for the tuning stub.

to be placed at a right angle to the end plate at the hub. Marking the arms to mount the spreaders is best done with the X frame temporarily assembled. Slightly flatten the end of the conduit, then mark and drill through to mount the spreaders. Put the bolts through (¼-inch is best) and pull up until the metal starts to flatten out again. Then whittle some small pieces of wood and fit them into the ends of the arm and pull up tight. Cut off the excess bolt and flatten it so that there is no chance of its coming apart. Assemble both frames, making sure all bolts are drawn tight.

A view of the completed end piece and X frame is shown in *Fig. 3*. The braces are not absolutely necessary, although if they are used they will considerably strengthen the array. Each brace arm is a piece of conduit about four feet long, left over from the 10-ft. conduit spider arms. About four inches is flattened down on each end, a single hole drilled and the flat section bent to conform with the frame and the boom.

Next cut out two additional pieces of Lucite to be used at the cross-over points. These should be at least 6½-inches long and 4 to 6 inches wide. *Fig. 4* shows the arrangement of the wires at the cross-over. The holes on either side are 5½-inches apart corresponding to the spacing of both the radiator and the reflector. On a diagonal line bisecting the holes in opposite corners, two more holes are drilled. These holes are 1 inch either side of the intersection of the diagonals. On the reflector the tuning stub is drawn up from these holes—on the radiator the coax feed enters at this point.

Now the wire is strung on the framework. The two loops of each element are put on independently of each other. Run the wire through the spreaders making a large square. Put the second loop on and tie all four ends to the cross-over block by making one loop and a twist joint on each wire. Do the same for the other element. Measure the sides and make whatever minor adjustments are necessary to bring the radiator sides to 8 feet and 1 inch, and the reflector sides to 8 feet and 5 inches (for 28.8 mc). When all measurements are made snub down each spreader with a short length of wire and solder for a very tight job.

On the reflector Lucite end piece drill two holes, 2 inches apart, about ½ inch from the edge facing the cross-over piece. These holes should be centered so that two wires may run from these holes directly to the cross-over piece, pass through the two holes on the diagonal and tie into opposite corners. This spaced line then serves as the reflector tuning stub.

Assembly

If the cubical quad uses the parts listed in the "Bill of Material" the array may now be assembled. Put the tee, the "one by short" nipple and the reducer together using a couple of pipe wrenches to pull them up tight. Screw the two one-inch pipe sections that are used as the boom into the tee and then into the element pipe flanges. Straighten and tighten the whole assembly. If all pipe connections are drilled and pinned this will prevent slipping.

Tie in the cross-over wires on both the reflector and the radiator and solder. Then attach the feed system as shown in *Fig. 5*. The phase inverting loop is not "hot," but the shield *should not* be grounded. The feed line as well as the phase loop may be taped to the support pipe with no ill effects.

Since each location presents a different problem, very little can be further said about the erection. The best and safest way seems to be to put the support pipe in place and then screw the antenna section on. In some cases a little guying may be necessary, but this type of beam is well balanced.

Tuning up is utter simplicity. Make a wire shorting bar for the reflector stub. Then ask a local to put on a low power signal near your operating frequency. Run an extension S-meter out to the quad and with the back of the beam on the local, slide the shorting bar up and down the stub until obtaining a minimum reading. This should be quite easy and, on completion, the cubical quad is tuned up to perfection.

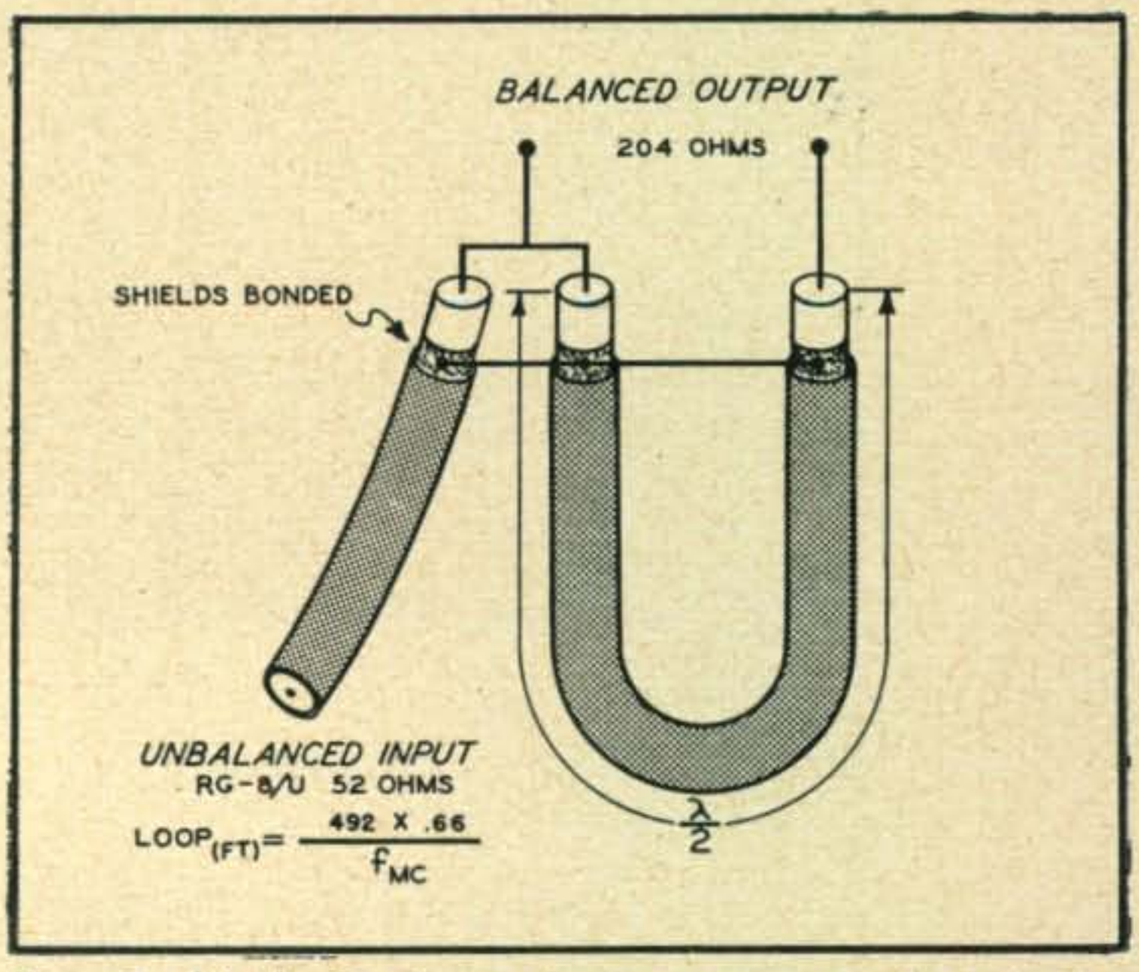


Fig. 5. Method of employing coax feed and the impedance matching transformer with a cubical quad radiator. At 28.8 mc the length of the RG-8/U loop is 11' 5½".