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special issue:

THE QUAD ANTENNA

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Canada

The Quad-Quad-Quad

Sixteen three-element quads for two or sixteen nine-element quads for 432 provide a very impressive antenna and signal.

What in devil is a quad-quad-quad? For that matter, what is a quad?

There are two common uses for the word "quad" as applied to antennas. When we put up four antennas in a square formation, we say that we have a quad of antennas. We may have, for example, a quad of 10 element yagis, for a total of 40 elements. The other use of the word applies to quad elements. A quad element is a square of wire, or tubing, which usually has a perimeter of 1 wavelength.

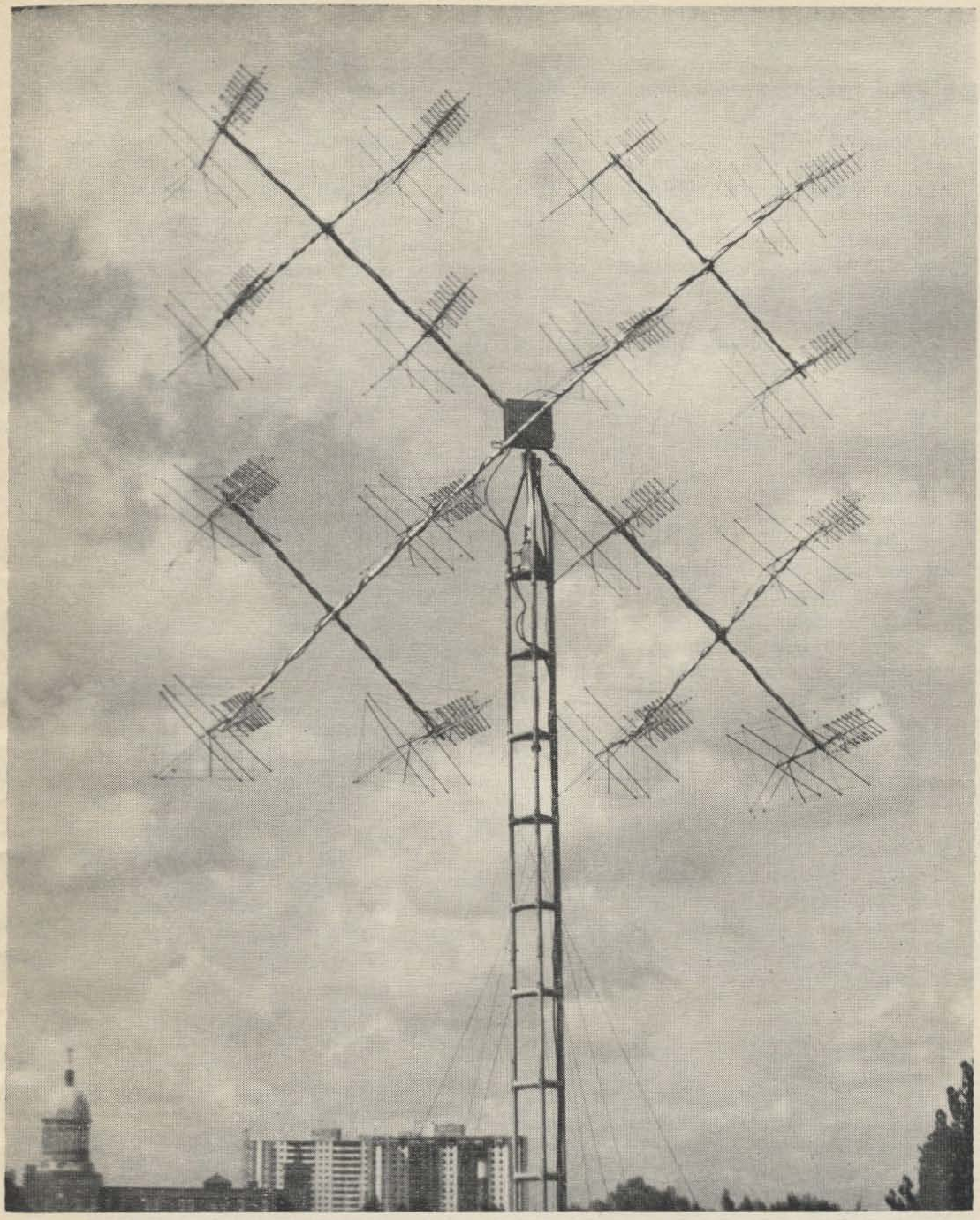
If you make four yagis with quad elements and mount them in a square formation, you have a quad of quads, or a quad-quad. Doug DeMaw described such an antenna in the May 1964 issue of 73. If you put up four quad-quads in a box formation, you have a quad of quad-quads, or a quad-quad-quad. Such a monster is the subject of this article.

In the summer of 1964, I had the booms drilled and the elements cut for four 8-element yagis. Just before buying the tubing to mount the yagis, I overheard Russ, K2KGN, extolling the virtues of his quad-quad, on 2 M. A bit of calculation revealed that it would cost less to start again from scratch and build a quad-quad, than to finish the yagis. The fact that no one else had a quad-quad in Metropolitan Toronto settled the matter. You can't do better than your buddies if you do what they are doing.

In making the quad-quad, my first mistake was the use of aluminum clothesline wire. It sure is nasty stuff to solder. My second mistake was the use of open wire feeders. Open wire is nice if you can keep the wires parallel and you live where there is no rain or snow.

In spite of its deficiencies, the antenna performed fairly well, when the feeders were not shorted.

The advantages of the antenna are low cost and small size for the gain achieved. The elements have gain over straight dipoles, because they are really two half waves spaced a quarter wave apart. This allows you to use shorter booms for a given gain. With three elements, the boom is so short that you can support the boom behind the reflector. This keeps the supporting structure out of the antenna's field, which is always good. It also allows you to mount half of the array below the top of the tower, since the tower will be behind the reflectors. With the center of the array right at the top of the tower, there is no need for a long strong mast to carry the whole weight of the array in a strong wind. Only 2 inches of my mast is between the tower and the bottom of the mounting plates at the center of the array.



The quad-quad-quad array at VE3DNR. This antenna has sixteen three-element quads on two meters and sixteen nine-element quads on 432 MHz.

Designing the beast

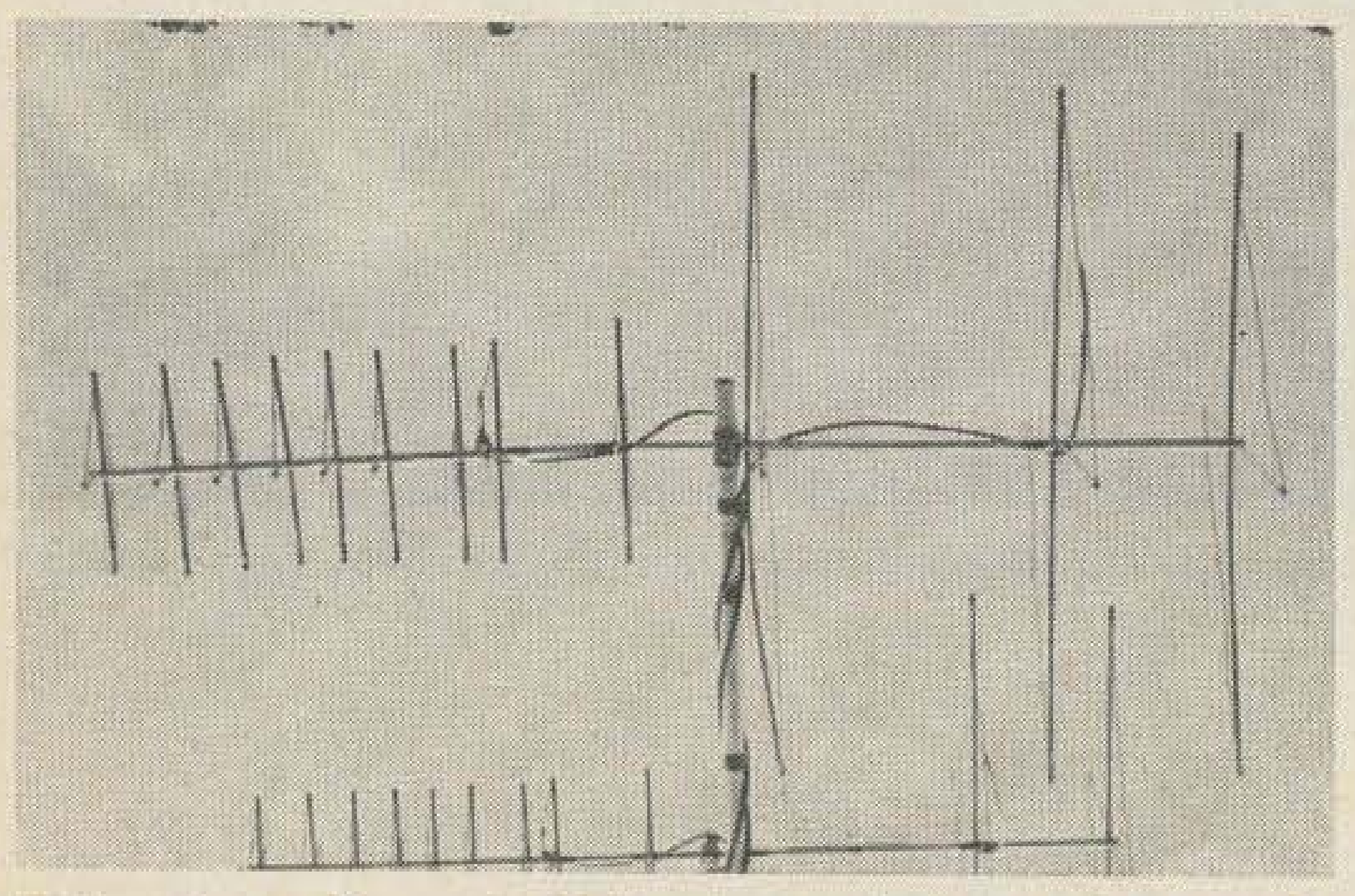
After I had the quad-quad up, Russ, K2KGN, put another bug in my brain. How about 16 quads? At first it seemed almost impossible for me. After months of thought, during the winter of 1964-1965, the difficulties disappeared one by one. Measurements and construction were done during the summers of 1965 and 1966.

When you start thinking about a quad-quad-quad, you soon realize that the spacing between yagis will be small, or the beast will be awfully big. A little more thought, with much calculation, reveals that this beast could also be awfully heavy. One of my early designs had a calculated weight of 120 pounds.

You must fight excessive weight as you would when building an aircraft. You would be surprised at the weight of such things as coax. The final design has a calculated weight of 54.4 pounds, including the mast and mounting plates. It is so light that I can lift it by the mast and remove the rotor, which is mounted inside the tower. The mast rotates in a collar at the top of the tower, so it is not necessary to hold it from going sideways.

I wanted to avoid mounting the booms cantilever style, but I still wanted to have the supports behind the reflectors. The solution was to extend the boom on the back side of the supporting tubing, and to put some sort of counter weight on that end. A nine-element quad for 432 MHz has the same weight as a three element quad for 144 MHz. So it was decided to put a 144 quad on one end of each boom and a 432 quad on the other end. The result would be sixteen 3-element quads for 144 and sixteen 9-element quads for 432.

The result had to be as small as possible, so it was necessary to redesign the quads to reduce the size. On the 144 quads, I found that I could bring the reflectors within 14" of the driven element without changing the gain appreciably. The reflector length was tuned for the minimum received signal off the back. The director was not at all critical. As near as I could measure it, the gain of one quad was 8 to 10 dB over a dipole. The front-to-back ratio was about 14 dB and there is a null off the side, as is usual with quad elements.



Side view of an individual quad from the quad-quad-quad array. The nine-element 432 quad is on the left; the three element 2 meter quad on the right.

The design was actually done at 145 MHz, to cover 144 MHz to 145.5 MHz. Antennas usually cover more megahertz below the design frequency than above. When I refer to the 144 quads, I mean the ones designed for the 2 M band, not just 144 MHz.

With the 432 quad directors, I used the idea of a slow wave structure consisting of five equal elements with matching elements at each end. This was described by Loren, K7AAD, in the May 1965 issue of the VHFER. The 432 quads had measured gains of 14 to 15.5 dB.

Measurement

The measurements on the individual quads were performed indoors. Many will look with disdain on such an idea. The main dangers would seem to be the reflections from the surroundings and the effect of the surroundings on the impedance. It was necessary for me to put my hands very near to the quads in order to change their gain. I also observed deep nulls, which would tend to indicate that the reflections were not very serious. The room was not typical. It was a second floor, unfurnished, room with non-metalic insulation.

One advantage of the quad is that it is only a quarter wave wide. Therefore, it does not come as close to obstructions as would an antenna with ordinary dipoles. This would make indoor measurements more feasible with the quad than with the yagi with straight elements.

Measurements were made using the quad as a receiving antenna. A signal generator was connected to a dipole and a super-regenerative receiver was connected to the quad, through 100 feet of RG-58/U cable. There was about 15 feet between the two antennas.

The idea of using a super-regen was to get a sensitive indication of when there was a change in signal. With a large signal present, the super-regen is very insensitive to changes in signal levels. On the other hand, at the receiver's threshold, very small changes in signal can be detected. So the attenuator on the signal generator was varied so that the signal could barely be detected in the receiver. This gave a sensitive indication of when the quad was made better or worse.

The idea of using cheap and dirty RG-58/U for measurements also comes from Loren, K7AAD, in the May 1965 issue of the VHFER. Tuning an antenna for the best SWR does only part of the job. A dummy load gives a fine SWR, but it makes a lousy antenna. What we want is the maximum signal in a 50 ohm load attached to the antenna, in the receiving case. A lossy piece of coax gives its characteristic impedance at one end, no matter what is at the other end. So 100 feet of RG-58/U at 145 MHz will show approximately 50 ohms to our quad, no matter how lousy the receiver's input impedance is.

When we have adjusted our antenna for the maximum received energy, there is no more that we can do. SWR or no SWR, our antenna is putting out as much signal into a 50 ohm load as it can. So, I don't know what the SWR of this antenna is, and I don't care. I have done the best I can.

Characteristics Of quads

There are several features of the quad which should be noted. The square quad, with sides at the top and bottom, works better than the diamond quad, with corners at the top and bottom. The difference is not large, but it is measurable.

As shown on **Fig. 1**, a current maximum will be wherever you feed the quad. Since the quad is 1 wavelength around, the opposite side will have the other current maximum. This puts the current minima, and the voltage maxima, half-way between. With a square quad, the voltage maxima are in the centers of the vertical sides. With the diamond, the voltage maxima are at the side corners. Since it is convenient to have the spreaders supporting the corners, the diamond has supports at its voltage maxima. Unless these supports are high quality insulators, and therefore expensive, you lose quite a bit of power in the supports. The square quad has its supports away from the voltage maxima, and is therefore more efficient.

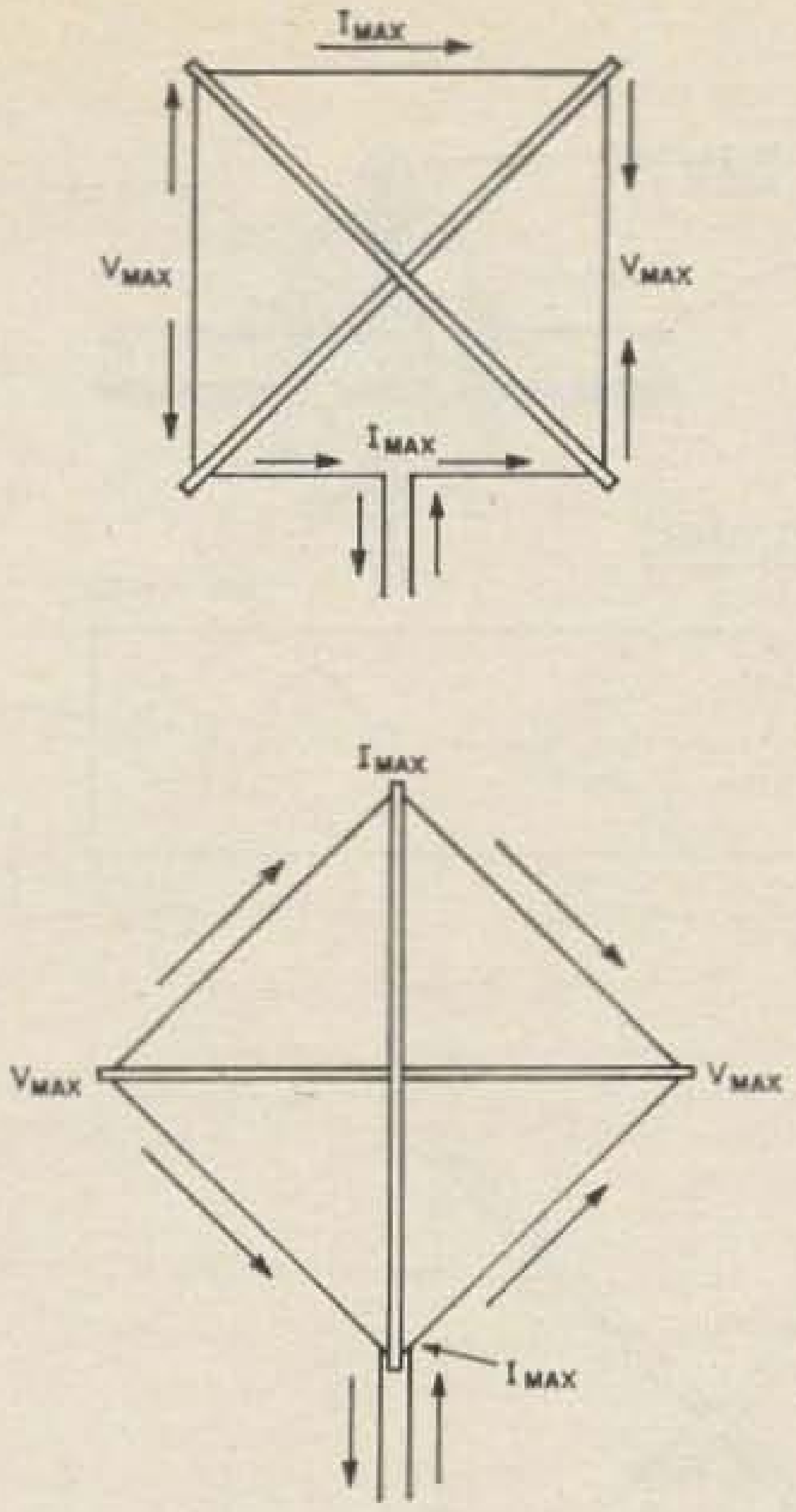


Fig. 1. The current and voltage maximums in square and diamond quads. The square quad is slightly more efficient that the diamond version because the supports are away from the voltage maximums.

For reasons which are a mystery to me, it seems better to solder the directors and reflectors at the current maxima. The opposite seems more logical to me, but my measurements clearly indicated this fact. Horizontally polarized quads should have their directors and reflectors soldered at the top or bottom.

The quad seems to be fairly sensitive to polarization. Rotating the quad on the axis of its boom by 90° produces a large change in the signal received. This is reasonable because the vertical sides of a quad, fed at the top or bottom, have currents flowing in both directions. This would cancel the vertically polarized signal.

The quad seems to be quite happy with unbalanced feeders. Measurements were made with a 432 quad fed with 50 ohm coax straight and with a 1/1 balun. The difference could not be measured. I was quite happy to save the weight of the baluns.

I can guess at the reason. With an ordinary dipole, the side connected to the braid of the coax is connected only to ground. It may get some signal from the other half, but it is operating at a disadvantage. With a quad, all of the element is connected to

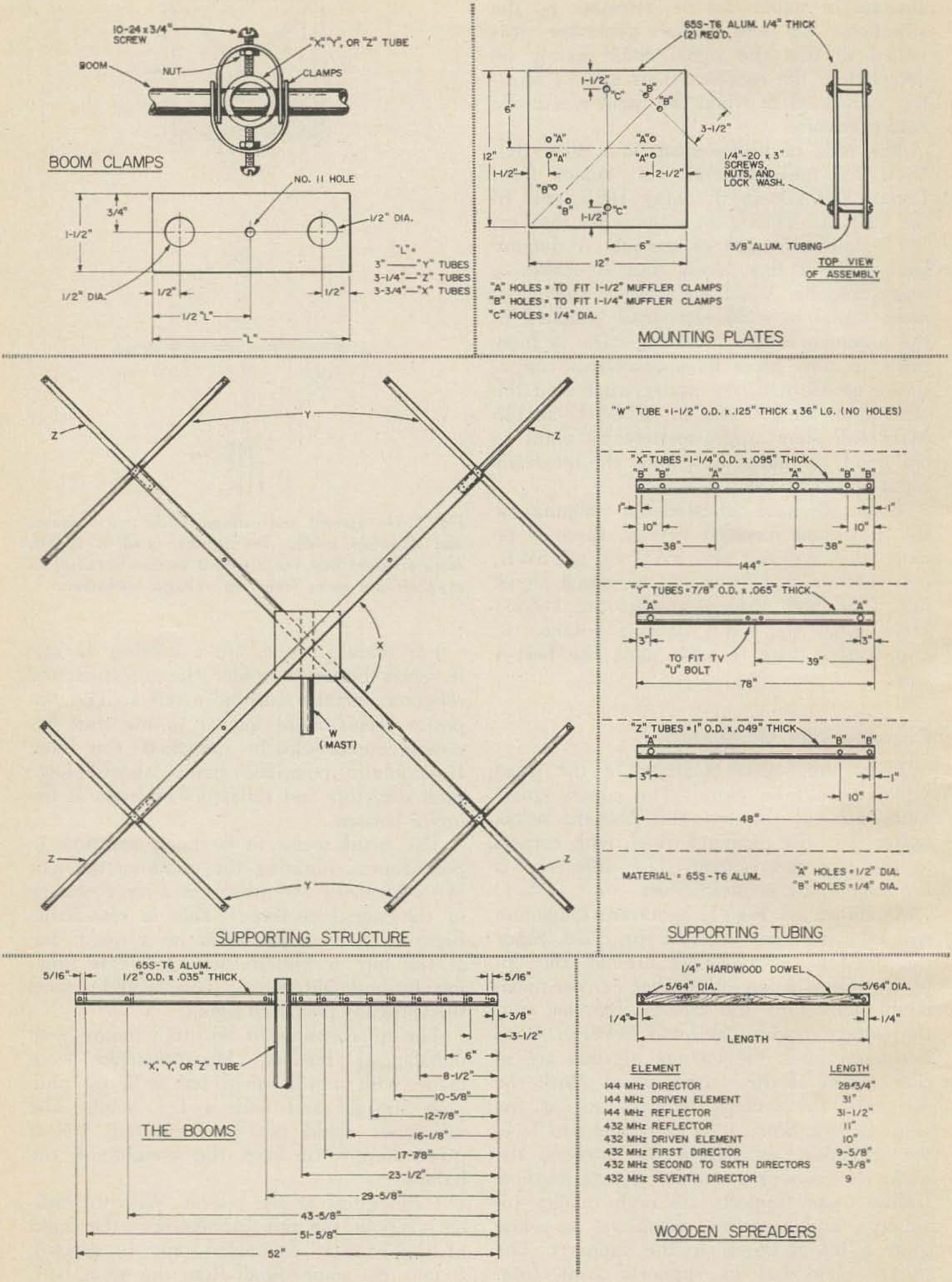


Fig. 2. Constructional details of the quad-quad-quad. The type of construction shown here results in a very strong unit that only weighs about 55 pounds.

the inner conductor, since the element is one piece of wire. It would seem that the quad element would be happier operating as an unbalanced antenna than would an ordinary dipole.

I see no reason to believe that there will be less fading with a large antenna. Although it is true that a signal will be received even if one quad is receiving nothing, it is also true that all the quads could be receiving something, but they could cancel each other. To me, one QSB situation seems as likely as the other.

If you want diversity reception, you must feed the signals from more than one antenna to more than one receiver, and add the audio signals. Only at audio frequencies can you keep the signals from the various antennas in phase. The 16 quads would seem to be good for a four channel diversity system. You could have the four quad-quads polarized horizontally, vertically and at the two 45° angles.

Construction

To save weight, the elements were made of #14 wire instead of the #10 used by Doug DeMaw. This may account for his superior front-to-back ratio. #10 wire for only the reflectors, which seem to be the most critical elements, may be a good idea. The spreaders were made of ¼" dowel instead of ⅜".

The position of the holes in the booms are specified by **Fig 2**. The booms were drilled with ¼" holes so that the spreaders could be passed through the booms. This saves the weight of the circular hubs that Doug used. The booms are very thin. There is danger that you will bend the booms where the holes are drilled. I bent one while installing the antenna. Since an individual quad is light, it can't do much damage if it falls. Therefore, we can take the chance that we have made the booms too thin.

It looks much better if you can make the holes in the boom line up; it looks less of a mess to the neighbors if the elements are in a line. A drill press is handy, but you can do a fair job with an ordinary electric drill. I doubt that perfect alignment will improve the electrical properties of the antenna.

The size of the elements have been given by specifying the lengths of the spreaders in **Fig. 2**. If the wire is under a *bit* of tension, you will come very close to getting the right perimeter every time. Even if the wire does not form a perfect square, the perimeter comes out roughly the same if the spreaders are the right lenght. The dimensions are not very critical. If you *try* to make the distance between the holes on the spreaders accurate, you should have more than enough accuracy.

Before putting the spreaders through the boom, you will find that you must file the holes in the booms. If you file the hole only enough to get the spreader in, you will need no adhesive to keep the spreader centered in the hole. It is easier on the nerves if the spreader stays put while you are trying to put the wire in place.

The booms are put through ½" holes in the supporting tubing. Therefore, you can only wire the quad on one end of the boom before putting the boom in the ½" hole. Since the 432-MHz quads have three times as many elements as the 144-MHz quads, you will naturally make the 432 quads first. You want to string as many elements as possible before getting the booms involved with the supporting tubing.

The ends of the spreaders were painted

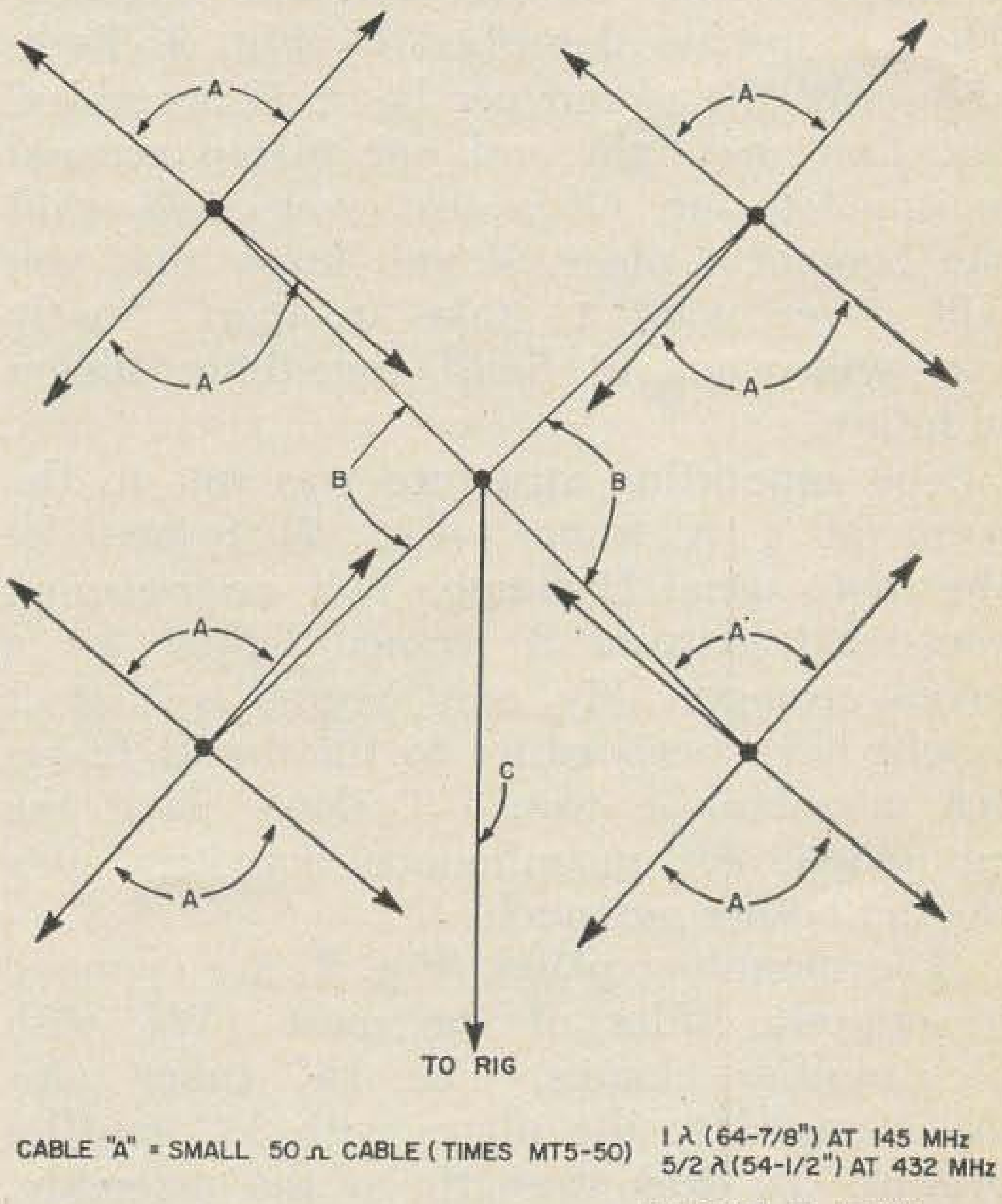


Fig. 3. Cable assembly required for feeding the quad-quad-quad; all the sections of the cable assembly are made from low-loss 50 ohm coaxial line.

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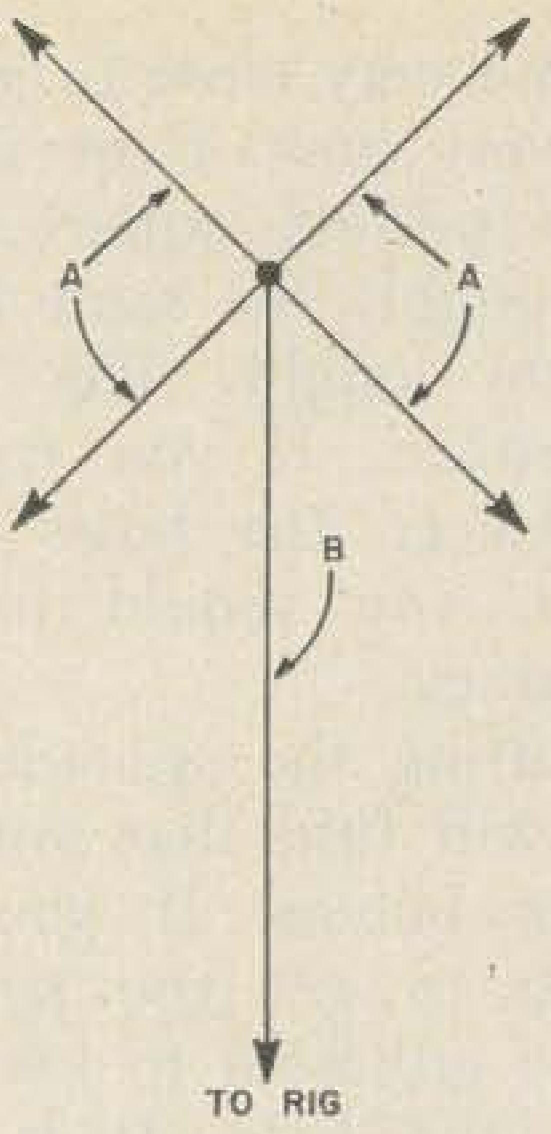


CABLE "A" = SMALL 100 Ω CABLE (RG-62A/U) 5/4 λ (85-1/2") AT 145 MHz
13/4 λ (74-5/8") AT 432 MHz

CABLE "B" = LARGE 50 Ω CABLE (TIMES MT4-50) ANY LENGTH

Fig. 4. Cable assembly for feeding a four quad quad-quad; this assembly uses both 100 ohm and 50 ohm coaxial line to obtain the proper impedance transformation to the main 50 ohm coaxial line.

with General Cement's Liquid Tape to cover the holes where the wire goes through. Then the whole spreader was painted with marine spar varnish.

The means of holding the booms in the ½" holes is one of the standard methods. The clamps are described by **Fig. 2.** Probably only one clamp per boom is necessary, but they are light and one clamp seemed marginal to me. Of course, you could weld the booms in place, if you know that you will never want to take it apart. Surely you will want to build something bigger in future.

The supporting structure was put in the form of a X frame. (**Fig. 2**) instead of the more usual H frame. This arrangement was used because it seemed lighter for a given strength. My only regret is that it would have been easier to tilt the H frame for moonbounce. Since I don't have the equipment for moonbounce activities, this doesn't bother me much.

The mounting plates (**Fig. 2**) are clamped to opposite sides of the mast (W) with 1½" muffler clamps. The 1¼" tubes (X) are clamped to the plates with 1¼" muffler clamps. To add strength to the assembly, ⅜" aluminum tubes are wedged between the two plates, as shown in **Fig. 2.** These tubes are held in place by ¼" screws which go through both plates and the ⅜" tubes. With this arrangement, each plate helps to keep the other plate from rotating around the mast in a wind. I can't tell you what holes to drill for the muffler clamps because your clamps will probably be different from mine.

The Z tubes fit inside the X tubes and 2" from the ends of the X tubes, using TV "U" bolts. Since you probably will use different "U" bolts from mine, I can't tell you what holes to drill in the Y tubes. The Y tubes are bolted to the same side of the X tube as its mounting plate. This makes it easier to line up the quads.

The Z tubes fit inside the Xtubes and are fastened with ¼–20 screws, 1½" long. The holes in all the supporting tubes are specified by **Fig. 2.**

Since the X tubes are separated by the plates and the mast, we must compensate for the space between them. All of the quads must line up as close as possible so that they are all the same distance from the other fellow's station. Otherwise, the signals from the 16 quads will not add in phase. This is, of course, more critical at 432 MHz than at 144 MHz.

The booms in the X and Z tubes are pushed toward the *center* of the array as much as possible. By the center of the array, I mean a line drawn parallel to the X tubes which passes through the mast. The booms in the Y tubes are pushed (in my case) ¾" away from the centers of the booms in the direction of the center of the array. The exact distance depends on the dimensions of your muffler clamps. This should make the quads line up to within ½" or so. You must also be careful that the Y tubes are clamped to the X tubes properly to make the quads line up. Finally, when clamping the X tubes to the plates you must rotate the X tubes so that the quads line up.

All of the muffler clamps and "U" bolts must be protected to prevent rust. I used Vaseline, because it is readily available and it has always done the job for me.

The cable harness

The coax connecting the quads together is small, RG-58/U size, cable. Naturally, the larger, RG-8/U size, cable would have lower losses, but more weight. Since the length of the cable from the common junction to any quad is short, the losses in small cable should be small. The additional weight of large cable seemed intolerable. Below the common junction, the weight of the cable is supported by the tower and we can therefore use large cable for the long run to the rig.

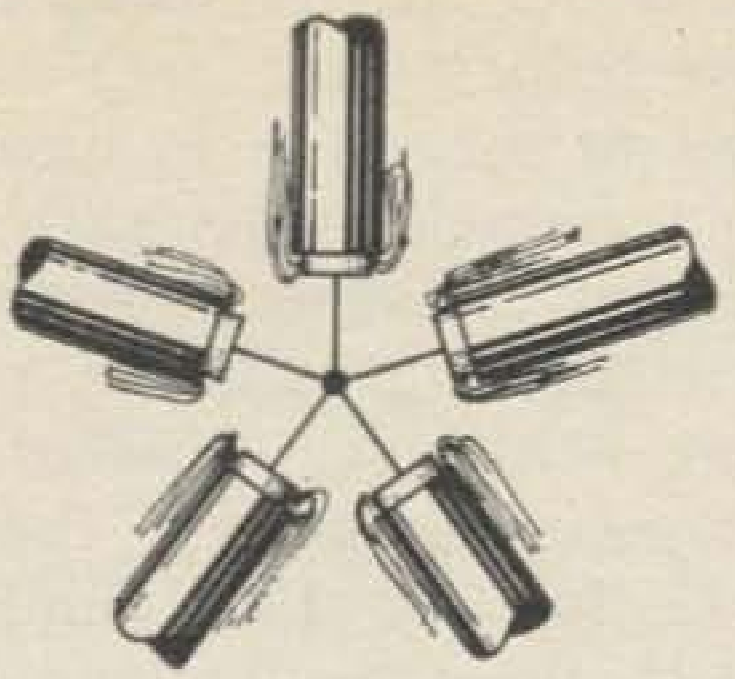
Fig. 3 shows the cable lengths for 16 quads. Each quad is designed to have an impedance of 50 ohms. So when four quads are connected together by 50 ohm cable, we have 50/4 ohms as the total impedance at these junctions. Each of these four junctions is connected to the common junction by 50 ohm cable which is an odd number of quarter waves long. These quarter wave sections transform the 50/4 ohms to 4 x 50 ohms. The main junction sees four 4 x 50 ohm impedances connected in parallel to give 50 ohms. The main cable to the rig is 50 ohms, so it is matched.

The cable used was made by Times Wire & Cable and distributed by Mosley. Any other cable could, naturally, be used if the velocity of propagation is taken into account. The dimensions in inches on **Fig. 3** are for the Times cable. The distance in wavelengths required is, naturally, the same for all types of cables.

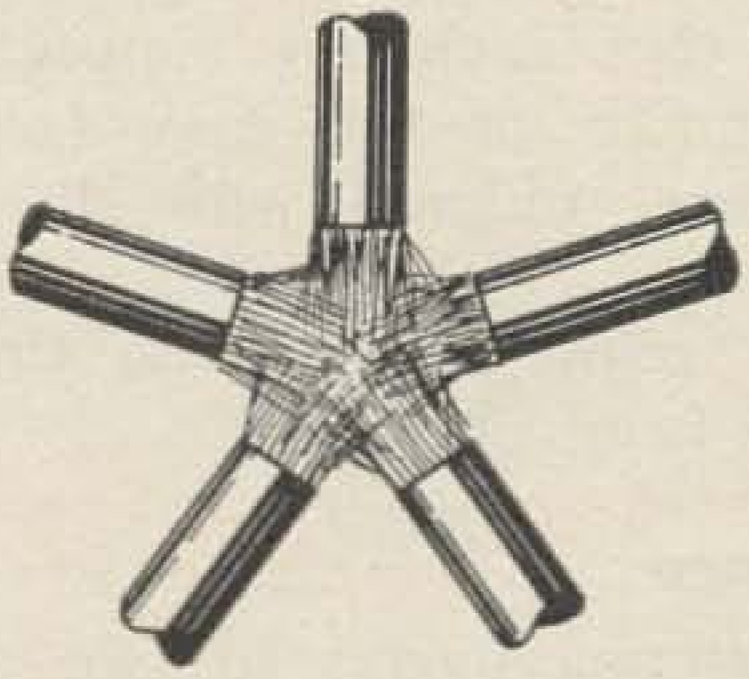
For a four quad array, 100 ohm cable could be used, as in **Fig. 4.** An odd number of quarter waves would transform the 50 ohms of each quad (100/2) to 2 x 100 ohms. Four cables connected together would give ¼ of 2 x 100 ohms or 50 ohms, to match the cable to the rig. The most appropriate cable I can find in the catalogues for the quarter wave sections is RG-62A/U; its impedance is 93 ohms instead of 100 ohms.

You may raise your eyebrows at the idea of connecting the cables without coax connectors. If you count the number of connectors that would be needed for the 16 quads on two bands, you can see the point of avoiding connectors. The weight, let alone the cost, of all those connectors is prohibitive. Therefore, we must do our best at making reasonable coaxial connections with our trusty soldering iron.

The five cables for each connection were laid out like five spokes of a wheel, as shown by **Fig. 5.** The inner conductors were soldered and the joint was insulated with tape. The outer braids were then folded over the tape to cover each side of the joint. The braids were then soldered together to form a solid shield all around the connection. The joint is fairly strong after the braids are soldered. The finished connection is then taped and coated with some weather-proof material. I wouldn't recommend the coating that I used, so there is not much point in naming it.



(A) SOLDER THE INNER CONDUCTORS AND TAPE CONNECTION



(B) FOLD THE BRAID OVER, SOLDER, AND TAPE AGAIN

Fig. 5. Connecting the coaxial cables together without using connectors. The coaxial connectors required for the quad-quad-quad are very expensive and add a lot of weight at the top of the tower.

Of course, you must be careful to connect all the quads in phase. All of the inner conductors must go to one side of the quads (eg. the right sides) and the braids to the other sides (eg. the left sides). If you goof on ½ of the quads, you will have a nice null where the main lobe of the pattern should be. These connections should be coated with something weather-proof.

The cables run up from the driven elements to the booms, along the booms and then along the supporting tubes. The cable is wound around the tubes and taped. The lengths of cable specified include enough slack to route the cable in the same way.

Getting it up

To show that it is possible, I decided to put up the beast alone. Unfortunately, my refusals of offers of help may have rubbed a few relatives, hams and neighbors the wrong way. It seemed important to show that anyone out in the sticks could do the job without help.

The key to success is to have a gin pole, which is a piece of pipe with a pulley on one end. You bolt the pole to whatever is already in the air, with the pulley at the top. Then you pull up whatever is next with a rope running over the pulley. My pole is 12 feet of 1¼" aluminum tubing, with a clothesline divider bolted to one end with a "U" bolt.

The antenna was put up in three sections. The mast and plates were put up first. Then each X tube was put up with all the stuff that each one supports. The two main junctions of the coax (one for each band) were soldered with the antenna in place.

It isn't really easy to do the job yourself, but it is possible.

Performance

The antenna moves in two major directions in a breeze. As you would expect, there is a strong tendency to rotate about the axis of the mast. Since the rotor is of the TV type, it is not strong enough to keep this rotation under control. There is a clamp at the top of the tower, which allows me to lock the mast to the tower. This clamp can be controlled from the ground using a "rope and pulley" system. The system works, but I hope to replace it with some electro-mechanical system that can be controlled from inside the shack. A heavy duty rotor would cost 4½ times as much and it still would not hold the antenna as well as my clamp. I have seen the way that some expensive rotors hold big ham antennas in Toronto and they impress me very unfavorably.

The other motion is rotation around the axis of the 1¼" tubing. This motion is not too severe because it is limited by how far the X tubes will twist. This motion shows that tube Y must be clamped firmly to tube X. Plenty of wind force is available to twist tube Y around the axis of the X tube. Perhaps, in my next model, I will put braces between the X tubes and the Y tubes.

The electrical performance is difficult to state definitely. This antenna is the first one at this QTH which was made at all properly. There is no well made antenna at the same height that I can use for comparison.

Comparing my results with others is also not valid. My QTH is not at all average. The 60-foot tower for the antenna sits on land 300 feet above and 1000 feet horizontally from Lake Ontario. The QTH is in Scarborough, the eastern borough of Metropolitan Toronto. To the west, my signal must fight its way across 18 miles of city and climb the Niagara escarpment, 30 miles away, before getting anywhere. To the east, there is smooth sailing over the lake for 150 miles. My coverage very much depends on the direction.

For what it is worth, I can hear W8KAY, Akron, comfortably out of the noise when his beam is on K2IEG. With the four quads, he was just audible. I have gained the ability to work the weaker boys (AM) around Rochester, N. Y. and the tower types in downtown Hamilton. On two occasions I have worked dx stations to the west and south immediately after Dennis, VE3ASO, worked them. They reported that my signal was 2 S points better than Dennis's. VE3ASO has 150 watts and 40 elements in a reasonably good suburban location in western Toronto. I have 60 watts.

I have no 432-MHz gear yet, so I can't report on the performance of the 432 quads in actual operation.

Conclusion

The quad can serve all types of two meter hams. Those who have little in funds and space can make one quad. It will fit, and rotate, in the attic or sit in the corner of the apartment balcony. Tell the landlord that it is a work of modern art, which it will be if you do a good job.

The average Joe can put up four quads without stretching the budget much; it should do as well as about 24 ordinary elements in far less space.

The ambitious can put up 16 quads, which might be enough for moonbounce. The 48 quad elements should do as well as 96 ordinary elements. OH1NL had only 24 elements in front of a screen to work W6NDG. You can also use the antenna for earth-bound contacts, because it is small enough to put on a tower. A large parabola on a high tower presents nasty mechanical problems because of the wind.

Why use straight elements, when you can get more gain with quads? Give them a try.

. . . VE3DNR

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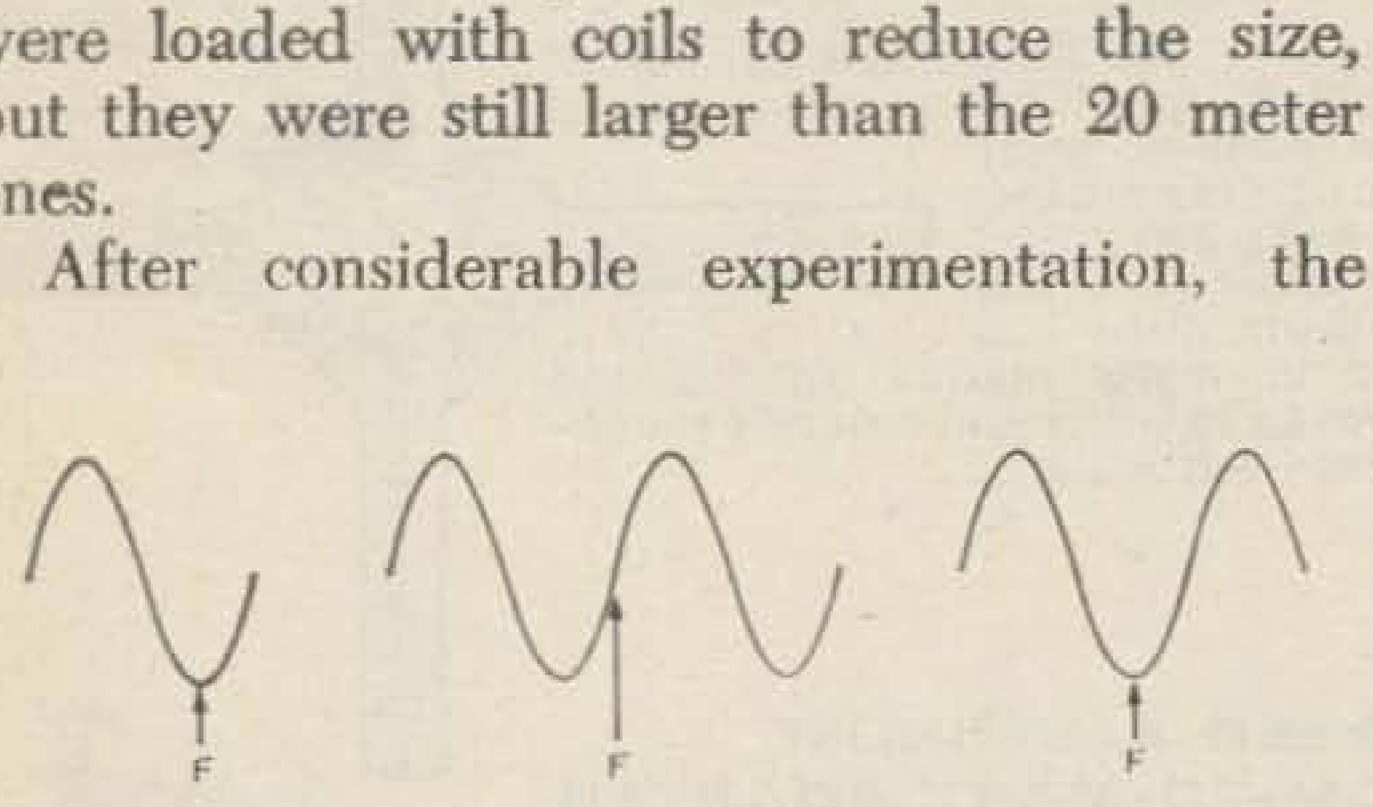
The Expanded Quad

This article describes an experimental expanded quad which is practical to construct and which has considerably more gain and directivity than an ordinary quad of equal elements. A three-element version was constructed which works excellently on 10, 15, 20 and 40 meters.

The antenna originated in an attempt to construct the expanded (XQ) two-wavelength quad described by William I. Orr, W6SAI in his book on "Quad Antennas'. This book should be read by anyone who plans to construct a quad antenna. Orr developed the "XQ" quad from the "Lazy H". It had a side length of ½ wavelength and the three-element version was estimated to have more than 10 db gain over a dipole.

Originally a 3-element, 3-band quad was constructed in which the 10 and 15 meter elements were the XQ 2-wavelength loops. The 20 meter elements were conventional 1.0-wavelength loops. The 15 meter elements were loaded with coils to reduce the size, but they were still larger than the 20 meter ones.

After considerable experimentation, the 2-wavelength XQ was given up because of structural weakness and because the high impedance (2,000-3,000 ohms) at the feed point made matching too difficult.



(a) (b) (c)

Fig. 1. Feedpoints in the current wave for (a), an ordinary 1 wavelength quad, (b), a 2 wavelength quad, and (c), the 1.5 wavelength expanded quad.

During the experimenting it was noticed that the 10 meter XQ had a strong resonance and low impedance at a frequency near the 15 meter band. A check showed that the antenna was 1½ wavelengths at this frequency, and the feed point at the center of the bottom side had an impedance close to 50 ohms.

With the belief that this 1½ wavelength loop would approach the high performance predicted by Orr for the 2-wavelength XQ, the antenna was reconstructed to have 3-element, 1½ wavelength loops for 10 and 15 meters and the 20 meter was left as the standard quad.

All three bands have been satisfactorily matched to a single 52 ohm RGSU coaxial feed line. However, matching would have been simplified and the interaction less if a separate line had been used for the 15 meter antenna.

Numerous contacts and comparative tests have proven the 10 and 15 meter 1½λ XQ's to be very effective. In over 90% of the contacts the S-meter rating received was better than could be given to the contact even though many of them used kilowatt linears in comparison to the 300 watts of the TR3.

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The directivity, front to side and front to back ratios are noticeably better than those of the 20 meter quad which was used for comparison. It is believed that the gain of the 1½λ XQ is close to that estimated by Orr for the 2λ XQ.

An added bonus is that the 15 meter 1½λ antenna works very well as a ½λ folded beam for 40 meters. This was observed after the antenna was erected so no attempt has been made to match it for better SWR or front to back ratio. As it is the SWR is 2.5 at 7.3 mc. and 1.05 at 7.2 mc. The element spacing constructed for 15 meters is much too close for 40 meters and a compromise should be made for more emphasis on the latter band.

Since the 1½λ XQ has performed so well on 10 and 15 meters, a 20 meter version has been planned. In the existing antenna, the spacing between the 15 and 20 meter wires is about 8 inches and there is considerable interaction when using a common feed line. With the 1½λ XQ for both 15 and 20 meters the spacing will be 3½ feet and the interaction should be greatly reduced.

With existing quad antennas, the 10 and 15 meter elements can be readily converted to the 1½λ XQ for improvement in DX operation.

The 20 meter 1½λ XQ requires a side of 25 feet and spreaders 18⅔ feet long. However, this is conservative when compared with some of the beams having 50 ft. booms and weighing 150 lbs. or more. A full size 40 meter quad at W3APO has 25 ft. fiberglass spreaders.

Theory

The reader is again referred to the book on Quad Antennas or the Antenna Handbook for the theory of the XQ and the detailed discussions of quads. **Fig. 1** shows the feed-points in the current wave for (a) an ordinary 1.0λ quad, (b) a 2.0λ XQ and (c) the 1.5λ XQ, when the feed is at the center of the bottom side. The impedance of the quad and the 1.5λ XQ is usually between 40 and 75 ohms, while the 2.0λ XQ will be in the enighborhood of 2,000-3,000 ohms. A ¼ wave matching section may be used to reduce the high impedance to that of the line.

Tne ends of the quad are in phase and can be electrically joined, but the 1½λ XQ antenna ends are out of phase and must be separated by an insulation.

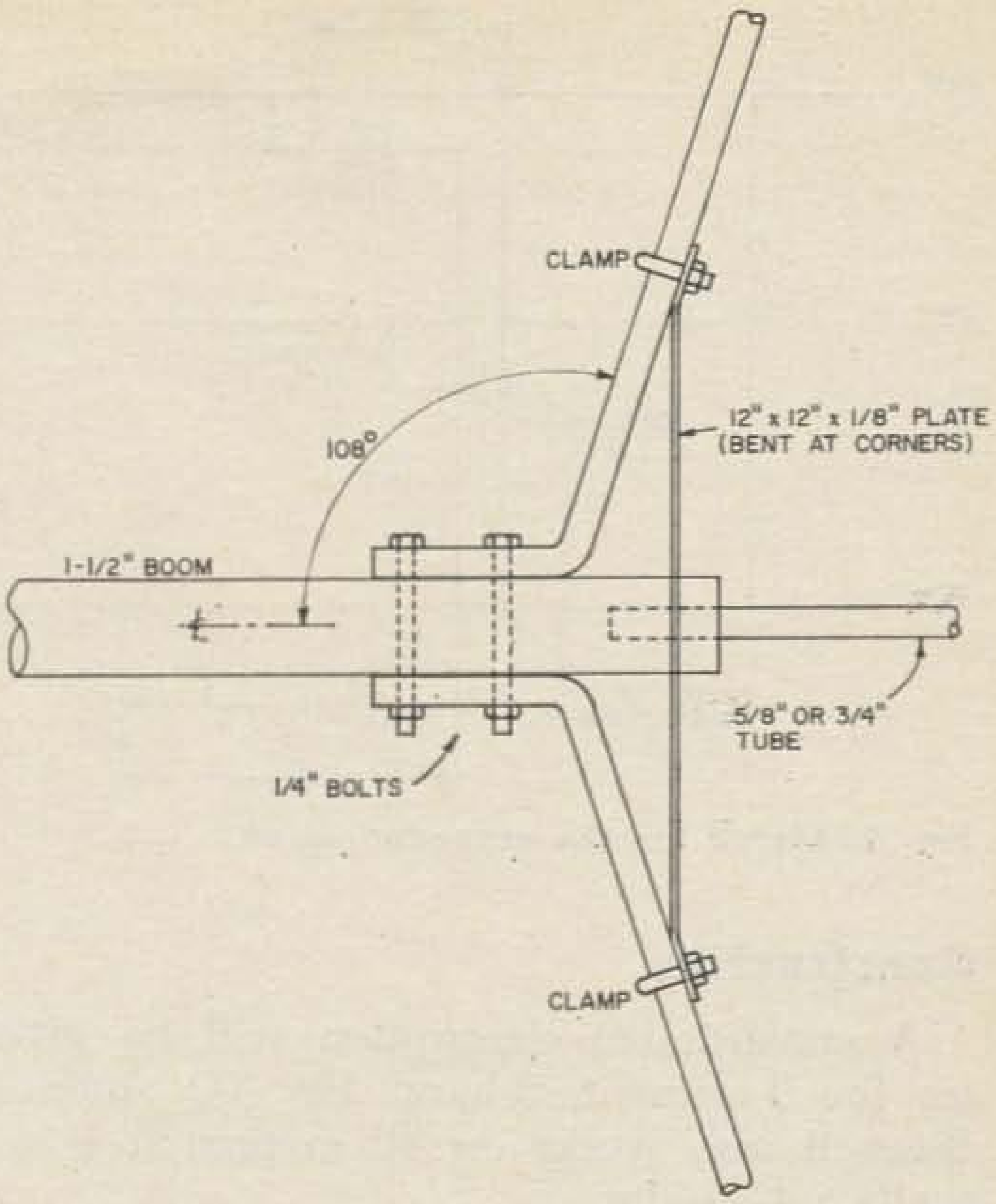

Fig. 2. Attaching the spreaders to the boom.

The 15 meter antenna works on 40 meters since 21 MHz is a third harmonic of 7.0 MHz. Actually if the antenna resonates at 21.4 MHz at 1½ wavelengths it will resonate at 7.14 MHz as a ½ wavelength antenna. Experience has shown that the tuning is broad enough to cover the whole 40 meter band.

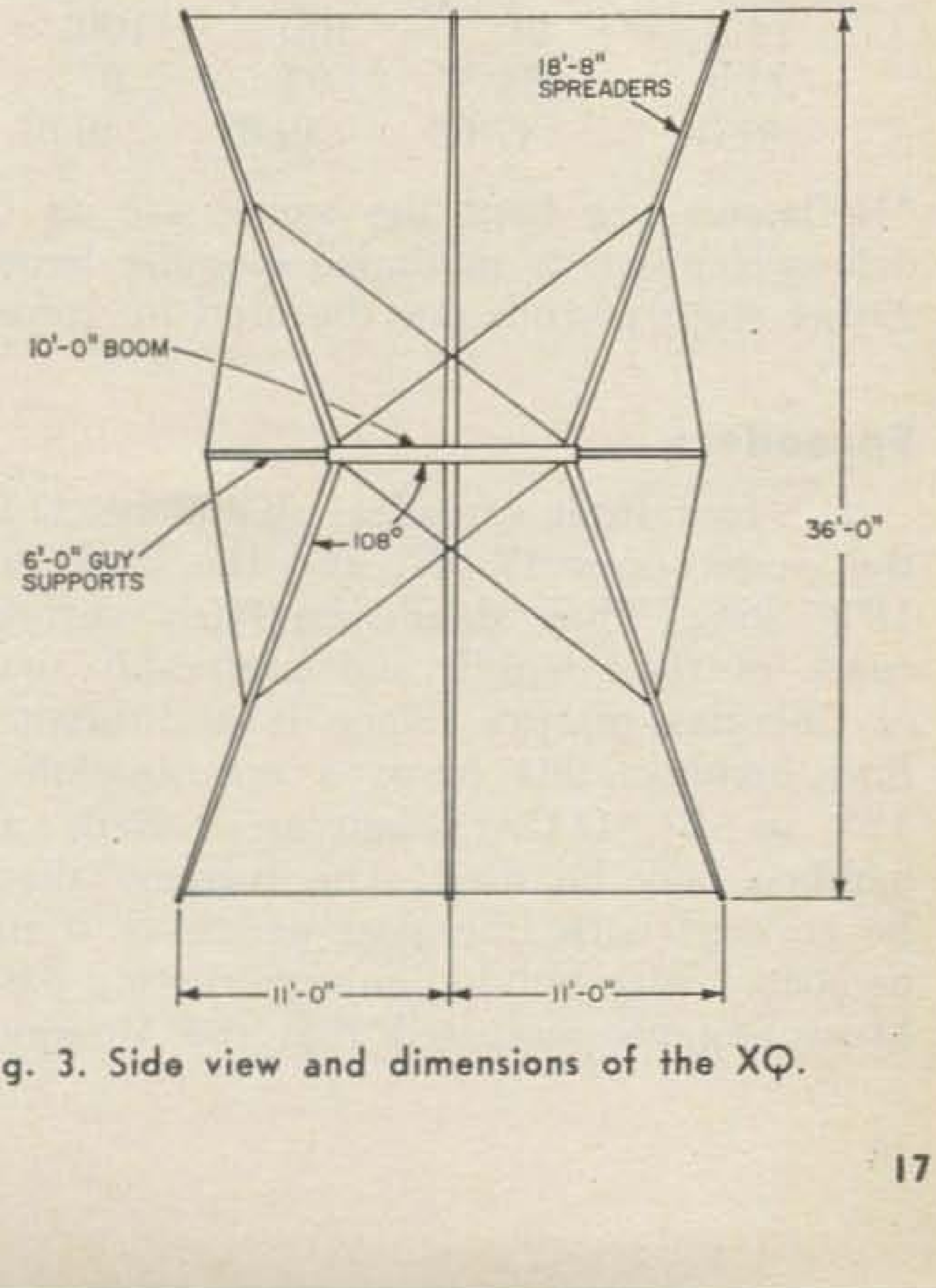

Fig. 3. Side view and dimensions of the XQ.

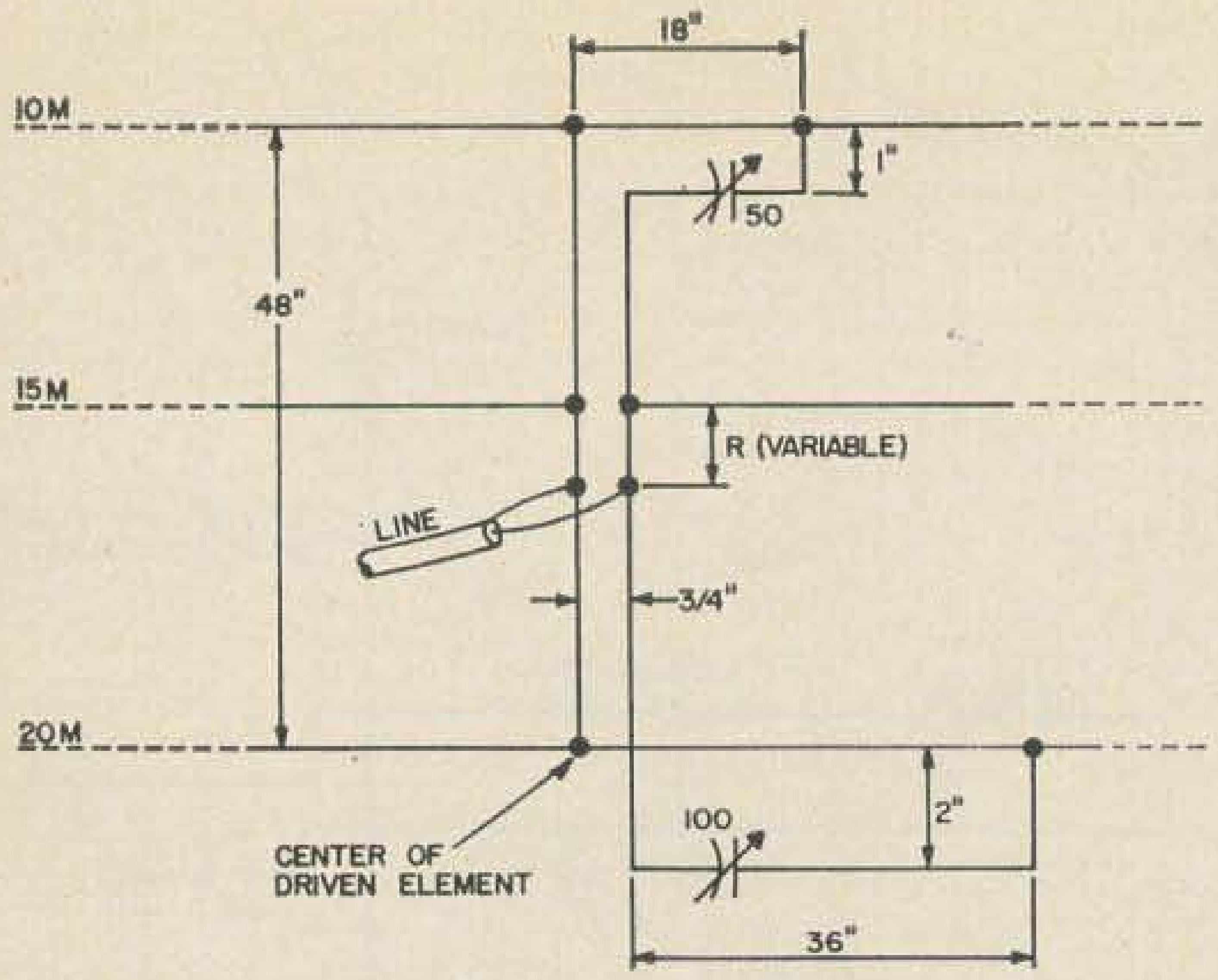

Fig. 4. Match for the expanded quad.

Construction

A construction description will be given for the 3-element, 3-band 1½λ XQ antenna. Since it also works on 40 meters, it is actually a 4-bander.

Although a 4-element antenna of this type would give a slightly better performance, it is doubtful if the additional cost, labor, and wind risk is justified. On the other hand a 2-element version would be easier to construct and should have a gain better than 7 dB on all bands except the 40 meter band which would have a gain of 4 or 5 dB over a dipole.

No. 14 solid enameled copper wire is used for the antenna and a little over 8 lbs. is required. The loop sizes are as follows:

Frequency	Director	Driver	Reflector*
14.3	96′	100′	100′
21.4	64′3″	67′	67′
29.0	47′6″	49′6″	49′6″

*Reflectors are kept the same size as the driven elements to minimize spreader length. Either stubs or coils may be used for tuning.

Spreaders

The four front spreaders should be 17′9″, the center ones 17′ 9″, and the back ones 18′8″ long. They should be fairly stiff because of their length and preferably made of fiberglass-plastics. Since it is difficult to find bamboo this long, a combination of 1½″ or 2″ O.D. aluminum tubing and bamboo may be used. The bamboo should be covered with fiberglass plastic or it may be coated with butyl-aluminum roofing paint. Measurements indicated that the aluminum paint had no electrical significance.

Boom

A ten foot length of galvanized steel or aluminum electrical conduit is suggested. This should be 1¼″ or 1½″ nominal pipe size or a 2″ O.D. stiff aluminum tube could be used. The boom is extended at each end with 6 foot lengths of ⅝″ or ¾″ O.D. light-weight tubing to serve as terminals for attaching the cross-bracing cards.

Assembly

Assembly of this antenna is quite an engineering feat. It was found convenient to attach the boom to a tilting mast in such a way as to permit rotation for access to the spreaders. The spreaders may be attached to the boom with purchased spiders. However, the author used sections of aluminum tubing as part of the spreaders and these were flattened and bolted to the boom as shown in **Fig. 2.** One foot square stiff aluminum plates were used for bracing.

Fig. 3 shows a section through the boom and center element. This is a diagonal section extending to opposite corners of the quad. Cross bracing with 150 lb. test nylon cord is used to increase strength and the ends of the spreaders are connected with it to hold the proper spacing. For clarity wiring is not shown on the figure.

Adjusting for frequency

Before attaching the connecting network each element was adjusted for proper frequency with a grid dip meter. The exact frequency was obtained by picking up the signal on a receiver. The driver elements were adjusted to 14.3 MHz, 21.4 MHz, and 29.0 MHz. The directors were adjusted to 14.9 MHz, 22.4 MHz and 30.3 MHz. Small tuning coils 2½″ diameter, and having a length of wire of about 4% of the element, were used to adjust the reflector frequencies to 13.6 MHz, 20.4 MHz, and 28.0 MHz. Tuning stubs could be used if preferred.

Connecting to the feed line

A single RG8U, 52 ohm, feed line was used and this was connected to the three antennas as shown in **Fig. 4.** The 48″ long header was constructed of No. 12 stiff copper wire and spaced ¾″ with micarta insulators. Gamma match connections were made to the 10 and 20 meter antennas and a direct connection was made to the 15 meter antenna. The line was connected to the header about 8" below the 15 meter antenna and the distance was varied to serve as a means for tuning.

The gamma match lengths and capacitances are approximate and are varied to obtain the best match. The values are affected by element spacing, proximity of the band loops, and height above ground.

Temporary variable condensers were used in the gamma matches. When tuning was complete they were replaced by short lengths of RG58U coax experimentally cut to give the same match. These were then sealed to keep out moisture.

Although the SWR is the final test, it is desirable to use an antennascope or impedance meter to make the matching adjustments. The antennascope construction is described in the "Radio Handbook" published by Editors and Engineers.

The method used for matching the 15 meter antenna to the line was made necessary by the interaction between it and the 20 meter quad antenna. With 1½λ XQ should be easier.

Since the gamma match lengths, capacitances, and the feed point are all interacting variables, considerable adjusting is needed to obtain a low SWR for all bands. However, the gamma lengths are not very critical and the 10 meter adjustments are almost independent of the 15 and 20 meter settings. So, after a preliminary adjustment of the capacitor on the 10 meter gamma, an optimization of the 20 meter capacitance and the feed-point setting (R) will bring the system to a fairly close balance.

The final SWR readings after the antenna was raised to 40 feet are shown below. These could have been improved by tuning with the antenna further from the ground.

Freq.	7.3	7.2	14.4	14.2	21.45	21.3	28.5	29.0
SWR	2.5	1.05	1.3	1.75	1.1	1.8	1.6	1.2

The results obtained from this antenna have repaid the trials and tribulations of building it. This includes repair after a windstorm blew it into the trees and a broken arm caused by a rotten ladder breaking under me.

. . . WA5KXY

An Inexpensive DX Antenna

Howard Krawetz WA6WUI
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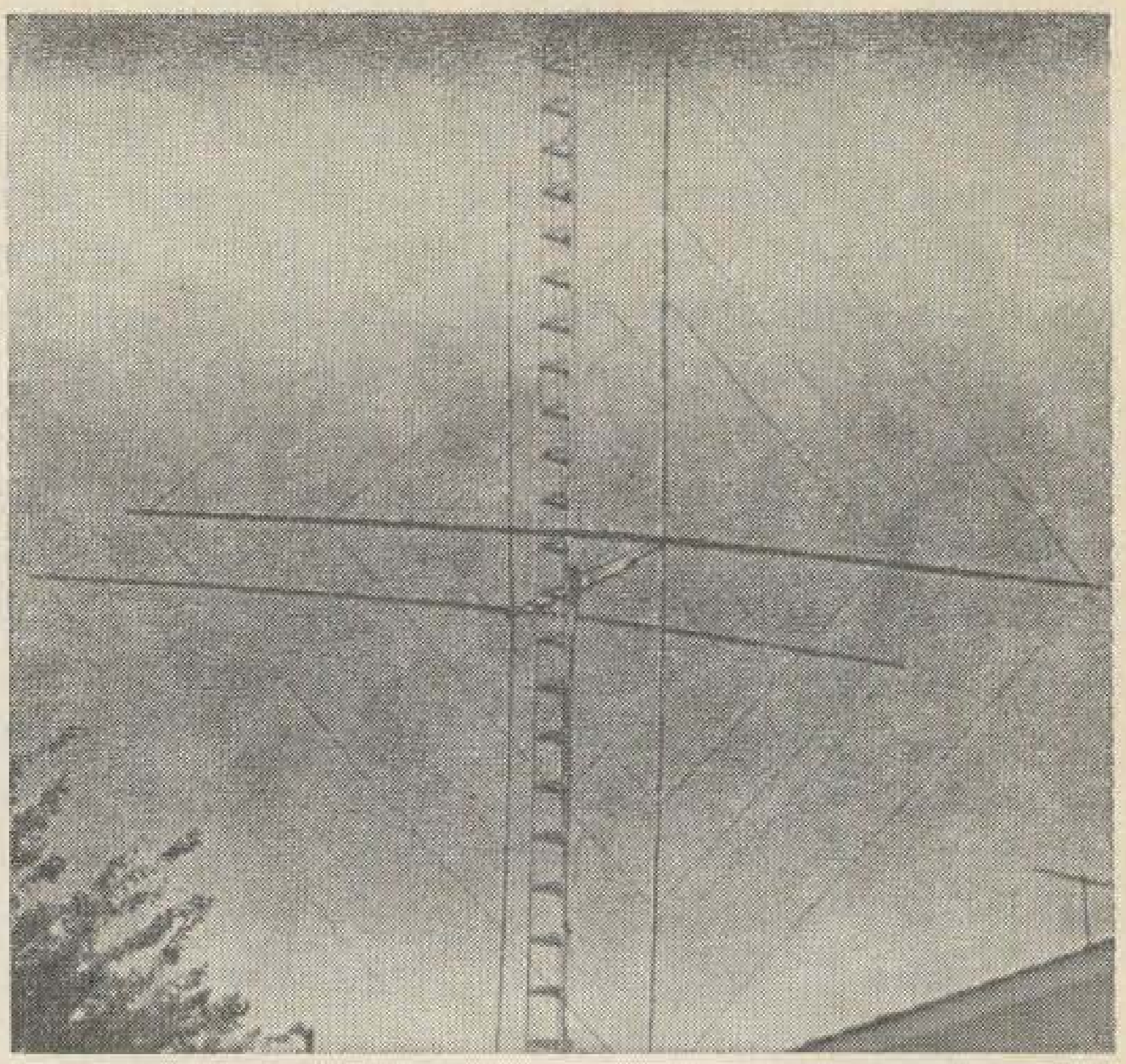
The increased activity in our ham bands has forced many good amateurs to use high gain directional antennas to obtain good solid contacts. The cubical quad antenna described here is quite directional, has high gain, and is inexpensive when compared to other beams (total cost is about $30).

The antenna is mounted with spreaders running horizontally and vertically rather then diagonally. This enables the metal spider brackets to be welded with greater ease and may also add some strength to the assembly. The spider brackets should be made of ⅛" x ½" x 2' aluminum angle (4 each required). Weld each pair on centers and at right angles. The spider to boom bracket should be made of ⅛" x 1" x 2' aluminum angle (2 each required). Weld in the center and at a right angle to the ½" wide legs. The metal may be obtained from a junk yard, some supply houses or any welding shop; take the materials to welding school or high school metal shop to be welded.



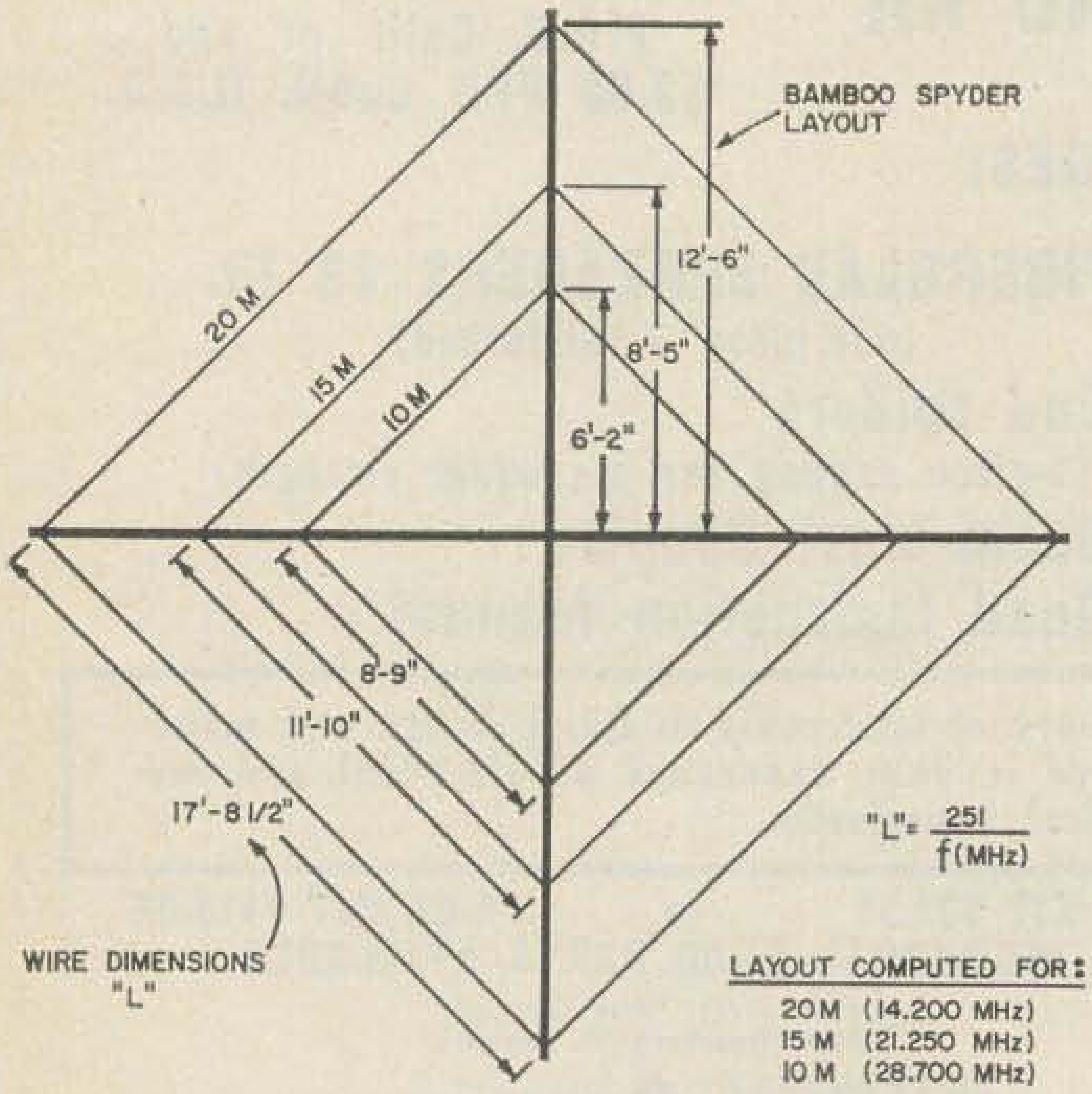


Fig. 1. Complete layout of the three band, two element quad; bamboo poles and a wooden mast provide very economical construction.

The boom to mast support bracket should be made of ⅛" x 1½" x 2' aluminum angle (2 each required). These two pieces should also be welded to each other at right angles and on centers (see figure 3).

The boom is made of 2" x 2" lumber. One piece is 11 feet long and the other is 6 feet long. These two pieces should be nailed together with the shorter piece centered below the longer piece.

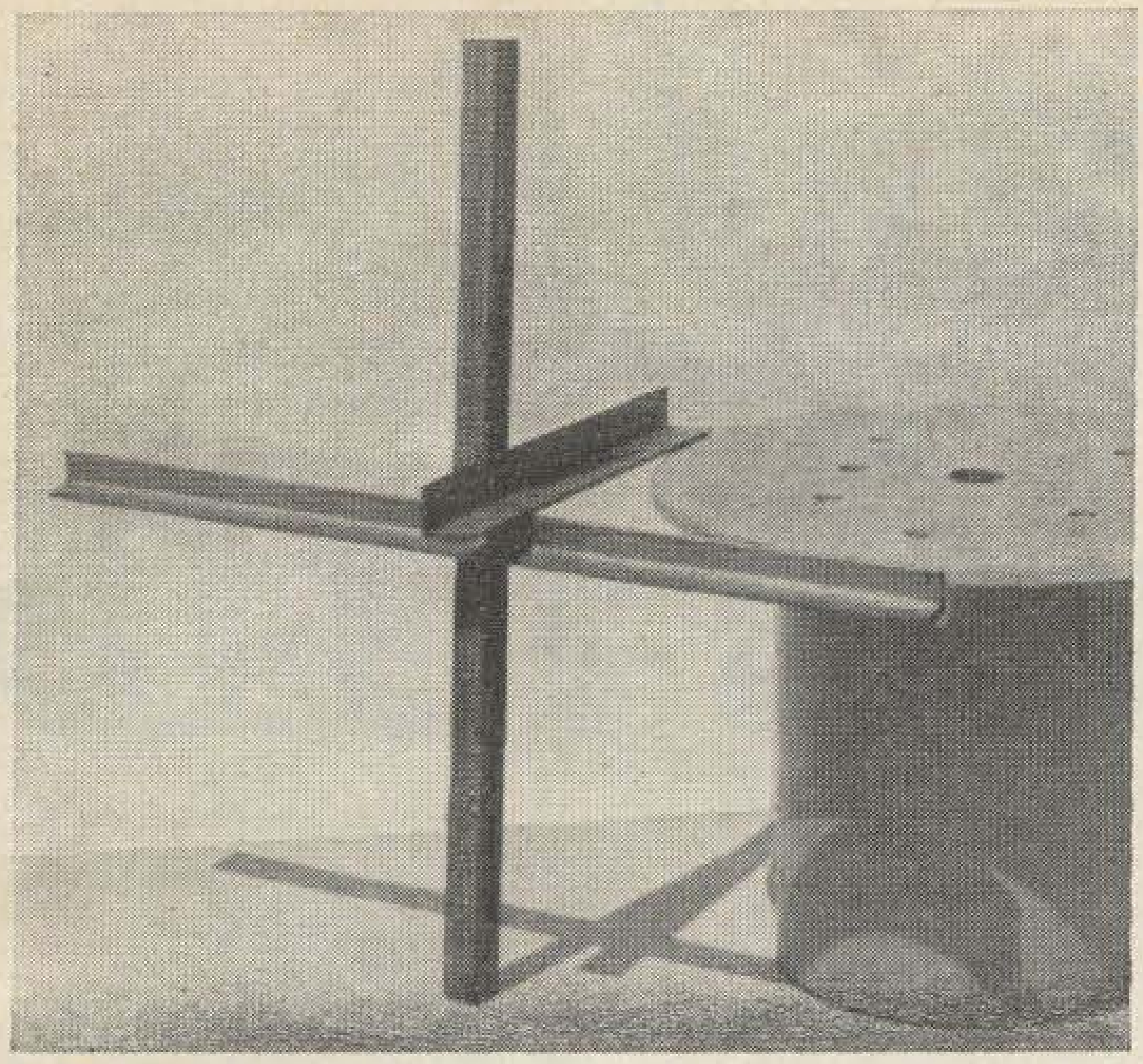
Center the aluminum boom to mast bracket on the boom, drill at least 8 nail holes through the horizontal leg and nail the assembly together.

Obtain the bamboo from a carpet store as carpets often come wrapped around bamboo poles. Try to get unsplit, straight poles 13' long and the thinner the better. You will need 9 poles and they should not cost over 25 cents each.

Cut up a couple of coat hangers into 3" lengths and form into wire hooks as shown in Fig. 3 inset.

Lay out the bamboo to the dimensions shown in Fig. 1. Drill holes through one side of the bamboo and install the wire hooks into 3 legs of the spider. On the fourth leg drill the holes all the way through the bamboo 1" above and 1" below the laid out dimensions for each spider assembly.

Assemble the bamboo to the spiders using



Construction of the homemade spreader assembly. This bracket is welded together from pieces of aluminum angle.

2 small hose clamps for each pole. Most auto stores have an ample supply of hose clamps in assorted sizes.

For each band, attach one end of the wire through the upper hole on the fourth leg. Wrap the wire around the spider and attach the end through the bottom hole. Attach the feed line to the wire ends on the driven element and solder. Short the wire ends together on the reflector element. Tape over the wire hooks to make sure the wire stays in place as it has a tendency to stretch with time.

Assemble the spiders to the boom with large hose clamps. (This is the toughest part.) Space the elements as shown in Fig. 3.

The last bamboo pole is the stabilizer. Cut it 9′ long, drill a small hole through two small hose clamps and screw them to each end of the pole. Attach the stabilizer about 8′ down on the fourth legs between the elements and parallel to the boom.

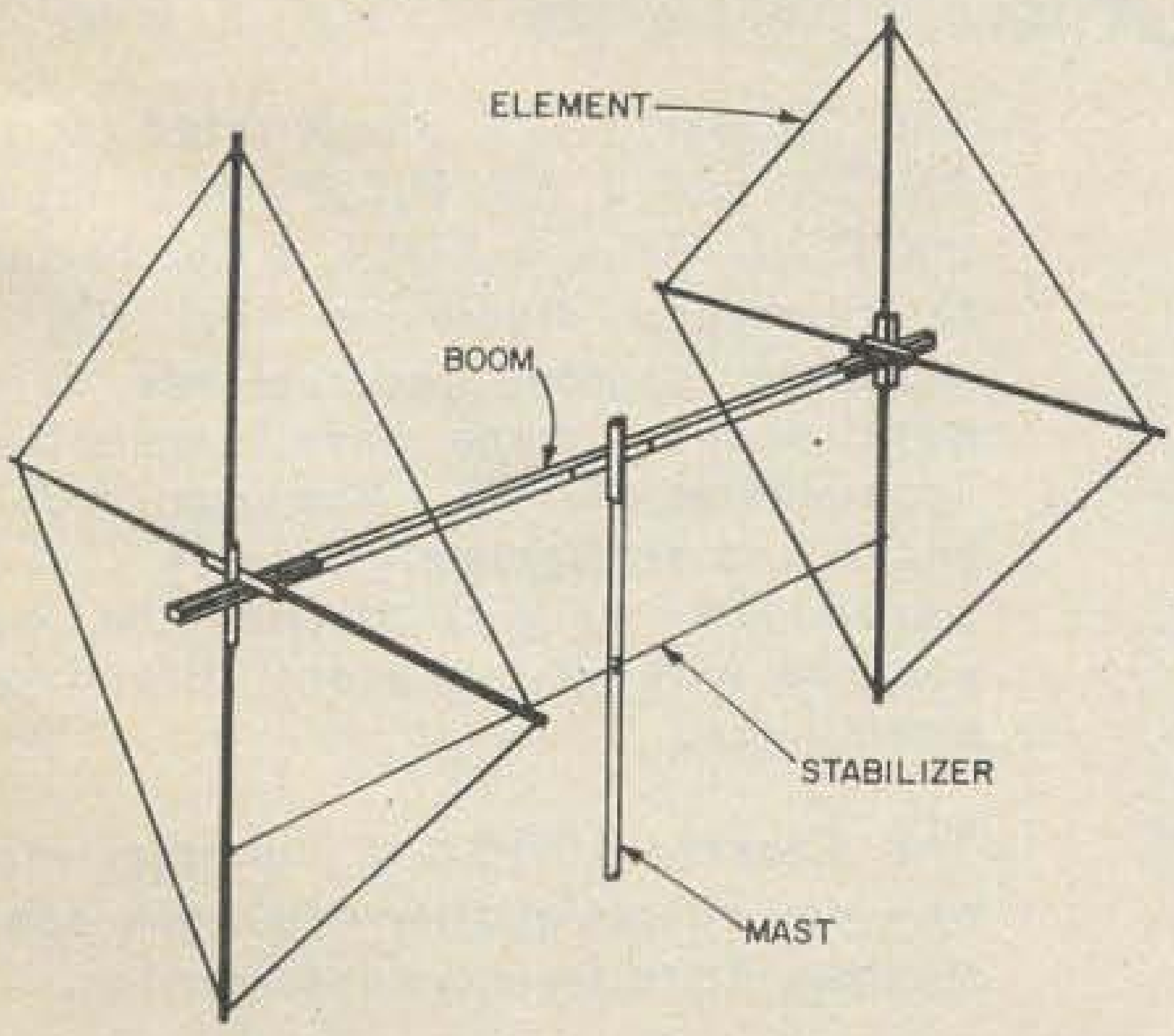


Fig. 2. Overall view of the two element quad showing the layout of the boom, mast and stabilizer.

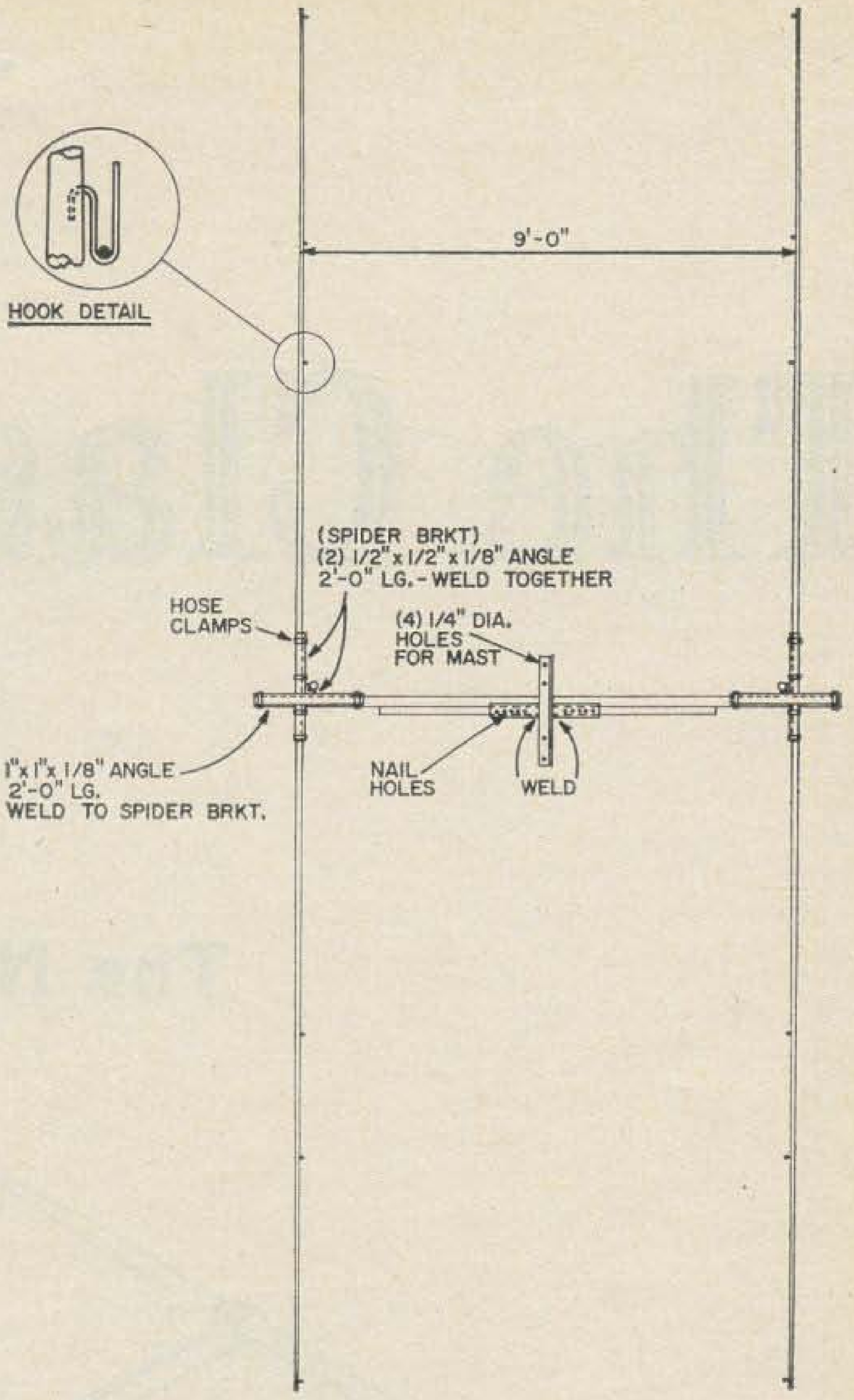


Fig. 3. Constructional details of the two element, three band quad.

Number 17 bare stranded copper wire is adequate for a QRP station, but where higher power is used, #12 copper wire should be employed.

Feed the array with 52 ohm coaxial cable. We found that two of the bands could be fed with the same feed line without appreciable loss, but the other band had to be fed with a separate feed line; this array has 10 and 15 meters on the same feed line with a separate line for 20 meters. It was also found that tuning stubs on the reflector were not absolutely necessary and were omitted from the installation.

We have received Q5 signal reports from Austrailia, New Zealand and Japan with 70 watts on the 10 and 15 meter AM bands. The antenna has been mounted on a 20 foot tower with good results, but much better results are obtained when mounted on a 40 foot tower.

. . . WA6WUI

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Lincroft, New Jersey 07738

The Miniquad

The Miniquad has two unusual features. 1) It is of all-metal construction[1], thus eliminating the problems of treating bamboo and welding spiders, only to have the whole antenna come tumbling down in a year or two, and 2) It is miniaturized[2], taking up less than *half* the space of a normal two-element quad. Added features of the Miniquad are its low cost, extremely light weight, and general ease of construction. The Miniquad can be built from parts of an old beam, or it can be fabricated from scrap aluminum. It is light enough to be turned by a low-priced TV rotator.

Theory

The antenna illustrated in **Fig. 1** is essentially a two-element quad with .12 wavelength spacing. Note that the two loops are insulated from the booms and thus from each other. The horizontal dimension is .25λ, while the vertical dimension has been reduced from the usual .25λ to .125λ. The difference is made up with loading coils at the bottom of each of the two loops. The Miniquad is thus *rectangular,* rather than cubical, in configuration. The 52-ohm transmission line is inductively coupled to the loading coil on the driven element.

Construction

The Miniquad lends itself to much flexibility in construction. The original version was built at almost zero cost from the parts of an old Telrex beam. However, eight ten-foot sections of tubing of almost any mater-

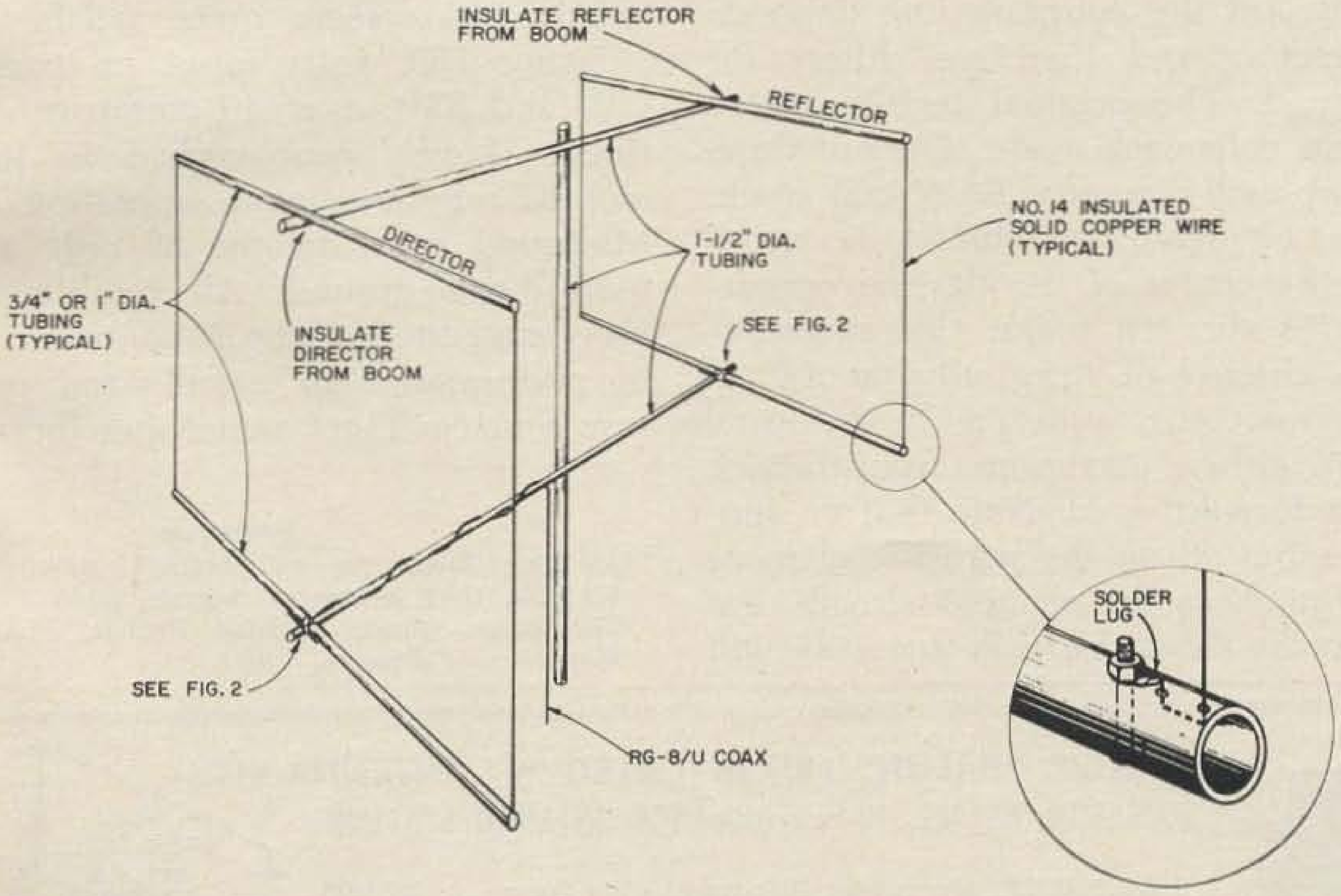

Fig. 1. Construction of the miniquad. For operation at 14250 kHz, element spacing is 100 inches, the horizontal supports are 208 inches long and the vertical distrance between the horizontal supports is 104 inches. The upper supports are insulated from the boom with standoff insulators.

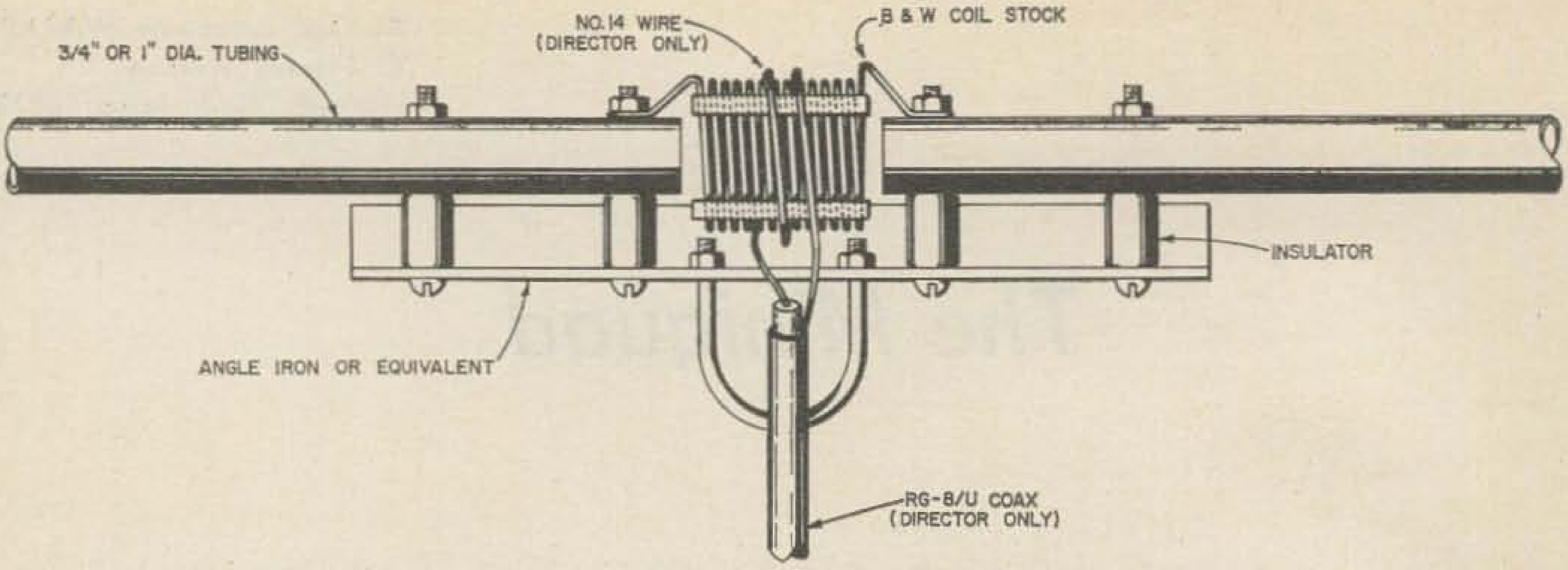

Fig. 2. Loading coil for the miniquad: a piece of coil stock two inches in diameter and three inches long is about right. The feedline is coupled into the antenna with a two or three turn loop around the loading coil.

ial and any diameter provide elements. Center mounts can be constructed of aluminum angle irons with standoffs as insulators. Masts and booms are made of TV masting. Standard antenna hardware is used for mounting the booms to the mast.

The vertical portions of each loop are of insulated number 14 solid copper wire, of the type commonly used in electrical housewiring. The wires may be attached to the ends of the horizontal elements by any convenient means. The wires should be tightened so that the top and bottom elements "bow" slightly toward each other.

Coils

The exact number of turns for the two loading coils and the coupling link depends on many factors and therefore differs for each Miniquad. The original twenty meter Miniquad has coils each made of about three inches of two-inch-diameter B&W coil stock. The driven element coil should be grid-dipped for the center of the desired operating band. Be sure to make this measurement in the absence of stray inductances.

The reflector coil is adjusted, in the usual manner, for either maximum front-to-back ratio or best forward gain. Note that no tuning stub is required on the parasitic element of the Miniquad, as the element already has a loading coil. Thus the reflector coil will simply have somewhat more inductance than that of the driven element.

The 52 ohm coax is coupled to the driven element by winding about five turns of insulated #14 solid copper wire around the loading coil. Since only this link is across the transmission line, a very low standing wave ratio may be obtained by proper choice of the number of turns.

Performance

The SWR of the twenty meter Miniquad used at WA2APT is less than 1.5:1 for the entire band, and close to 1:1 over much of the band. Transmitter output tuning is quite broad, with retuning required only for large frequency changes. Front-to-back and front-to-side ratios seem quite satisfactory.

Using 150 watts input on twenty meter CW and SSB, over 40 countries on all continents have been worked in just a few months of occasional operating, using the Miniquad at a height of only twenty-five feet above ground. All qualitative indications suggest that the Miniquad comes close in performance to a full-sized quad. Who says you can't get something for nothing?

. . . WA2APT

Footnotes

[1] "All-Metal Quad for 15 Meters", Edwin Fehrenbach, KZ5EG, *QST Magazine*, March, 1961.

[2] "The Short Quad," Walter Pinner, WA8BHP, *QST Magazine*, February, 1964.

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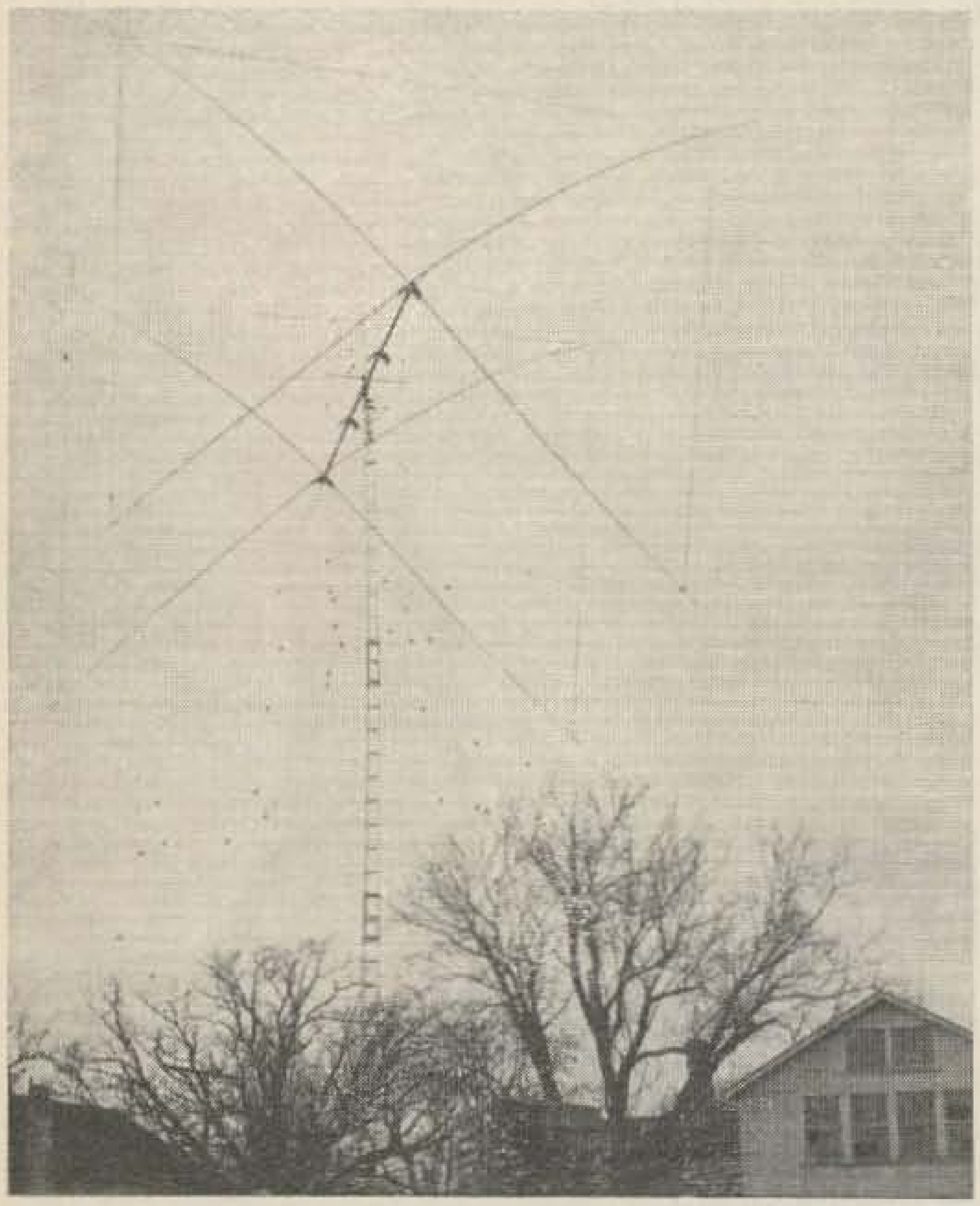
Hollywood, California 90027

A Full Size 7 MHz Rotary Cubical Quad

Have you been on 40 recently? Did you notice how much harder it is to consistently work DX with a moderate antenna? Here is the solution to your problem, but you must have the time, patience, cash, a large backyard and no neighbors! Although this antenna was erected way out in the country on a farm in southern Wisconsin, it has attracted considerable attention. The permanent residents of the farm have been continually asked about it and passing airplanes occasionally drop down for a closer look. The volume of this antenna is *only* about 36,750 cubic feet, but that is enough to capture lots of DX! Compare the size of this antenna with the shed in the picture. This is not the first 7 MHz cubical quad, but it is one of the very few in existence; K6PRU used one several years ago and recently W8BAR put one up.



The full sized forty meter cubical quad. Compare its size with the barn in the lower right hand corner.

If one takes a simple half wave folded dipole antenna (0 dB gain), stretches it into a square or rectangle in a horizontal plane, and feeds it at an appropriate place, 3 to 6 dB gain can be obtained (**Fig. 1a** and **1b**). This is similar to taking a 2 element parasitic beam and bending the elements 90° at a point ¼ of their own length back from each end and joining them (**Fig. 1c**, **1d** and **1e**).

If two identical antennas are properly spaced, 3 dB additional gain can be obtained; theoretically, this arrary has 6 to 9 dB gain. Suppose, however, for convenience in feeding the elements of **Fig. 2A** (**a** and **c** *and* **b** and **d**) are not connected mechanically as in **Fig. 1e** but are connected inductively and capacitively. Also, instead of connecting the two feedlines to **a** and **b** together, omit one feedline and connect **a** and **b** mechanically by moving the bent tips into a vertical position. Assume that the same degree of coupling can be obtained regardless of the type, mechanical or inductive. *Do* the same with **c** and **d**; the result is shown in **Fig. 2C**, the standard cubical quad. It can be seen that the radiating portions of the antenna have not been moved nor their length changed; only the method of feed has been changed. Thus, the gain should remain the same, about 6 to 9 dB.

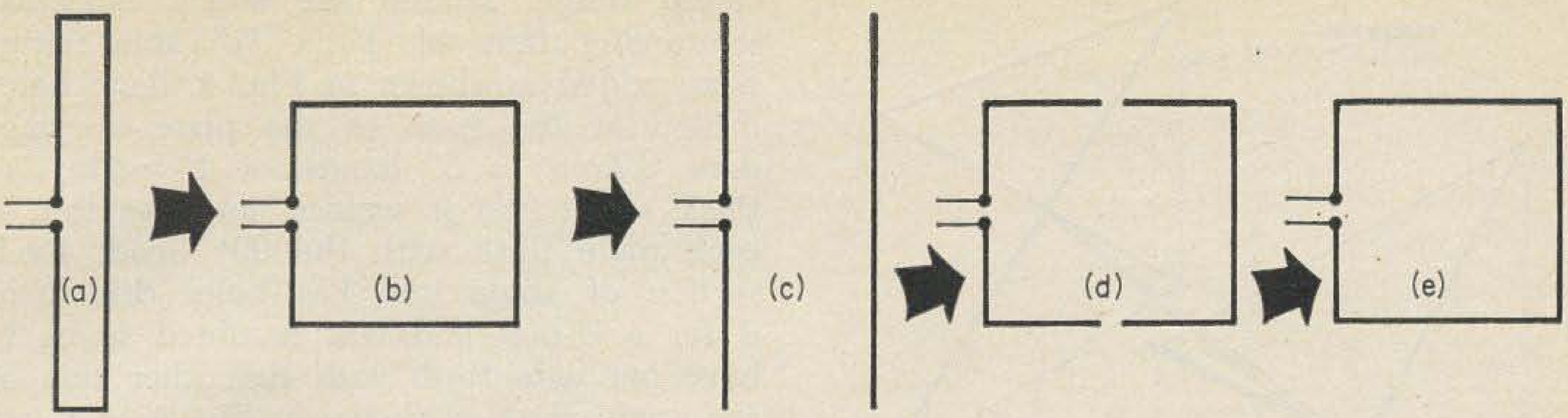


Figure 1

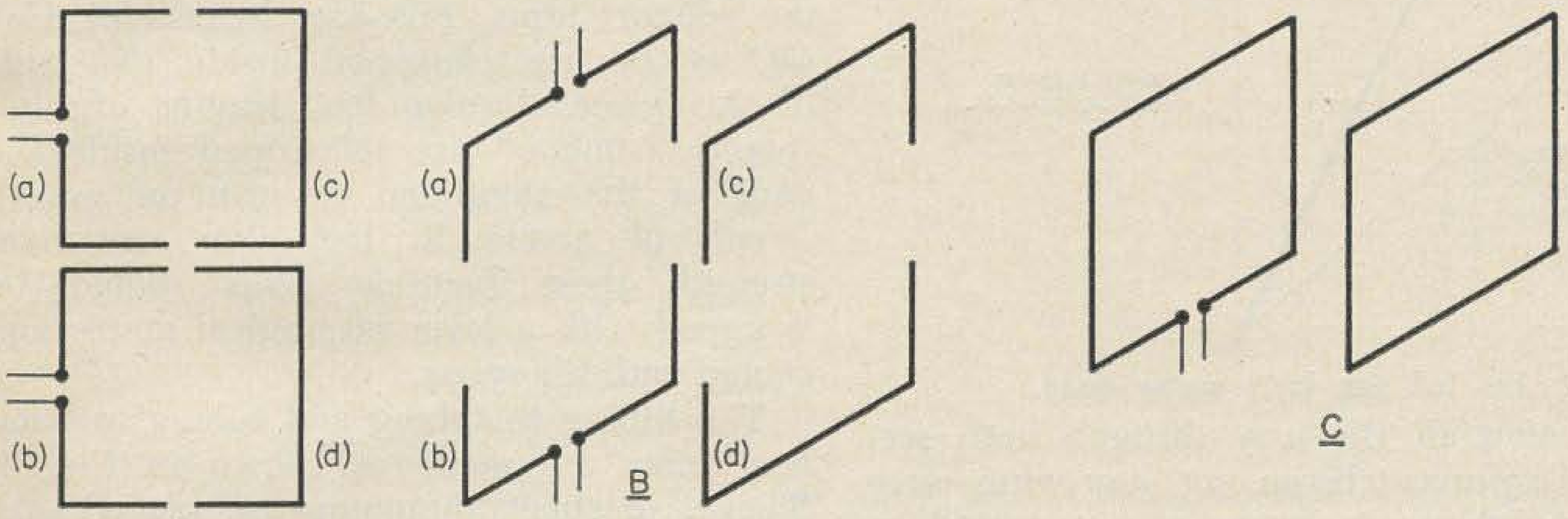


Figure 2

Development of the cubical quad from the folded dipole in Figure 1 and into the two element quad in Figure 2. This development is completely explained in the text.

A full size 7 MHz quad requires supports for two squares of wire that are about 40 feet on a side and spaced 30 feet apart. A structure of several tons could conceivably be used to support these two loops of wire but a more practical way is to build a rotatable support system of minimum weight, bulk, and cost that will withstand wind, bird and ice loading.

Although I used a rather small 55 foot crank up tower, something heavier is advisable. The mast is a six foot length of 1¼″ solid steel shaft; a surplus motor system with a gearbox and selsyn are mounted at the base of the shaft. The shaft is coupled to the motor through a slotted section of pipe mounted on the rotor. Right angle gears connect the shaft to a Roto-brake* mounted on the side of the tower. A greased sleeve mounted in the top of the Tri-Ex tower acts as a thrust bearing. Just above the top of the tower a 24″ x 12″ x ¼″ steel plate is mounted on the 1¼″ shaft by means of four U bolt muffler clamps as shown in the photographs. On the back of this plate four home made 4″ U-bolts made from ⅜″ Redirod were installed. The 30′ x 4″ OD 0.06″ wall aluminum boom is supported at its center by these four clamps. A sleeve of inner tube rubber around the boom restricts slippage of the boom during wind vibration and a semicircular sleeve of aluminum sheet on the outside of the rubber (on the clampside) prevents tight clamps from kinking the boom. A heavy ground strap grounds the boom to the tower and to a ground post. A bolt through the boom could have been used to prevent boom rotation but there was some possibility that this might weaken it at a critical point.

Additional boom support is provided by the boom guy system. A second steel plate is clamped on the mast just above the boom support plate **(Fig. 4)**. A piece of pipe is clamped on the backside of this plate and holes were drilled at the ends to accommodate screw eyes. Guy wires of galvanized #9 wire run from these screw eyes to the boom tips where they are anchored with irrigation tubing clamps. These four guys hold the boom firmly in the horizontal plane.

Since the 6′ steel shaft was too short, an extension of 1¾″ OD water pipe, 6′ long was mounted on top of it with two

* Hy-Gain Antenna Products Corp., N.E. Highway 6 at Stevens Creek, Lincoln, Nebraska 68501.

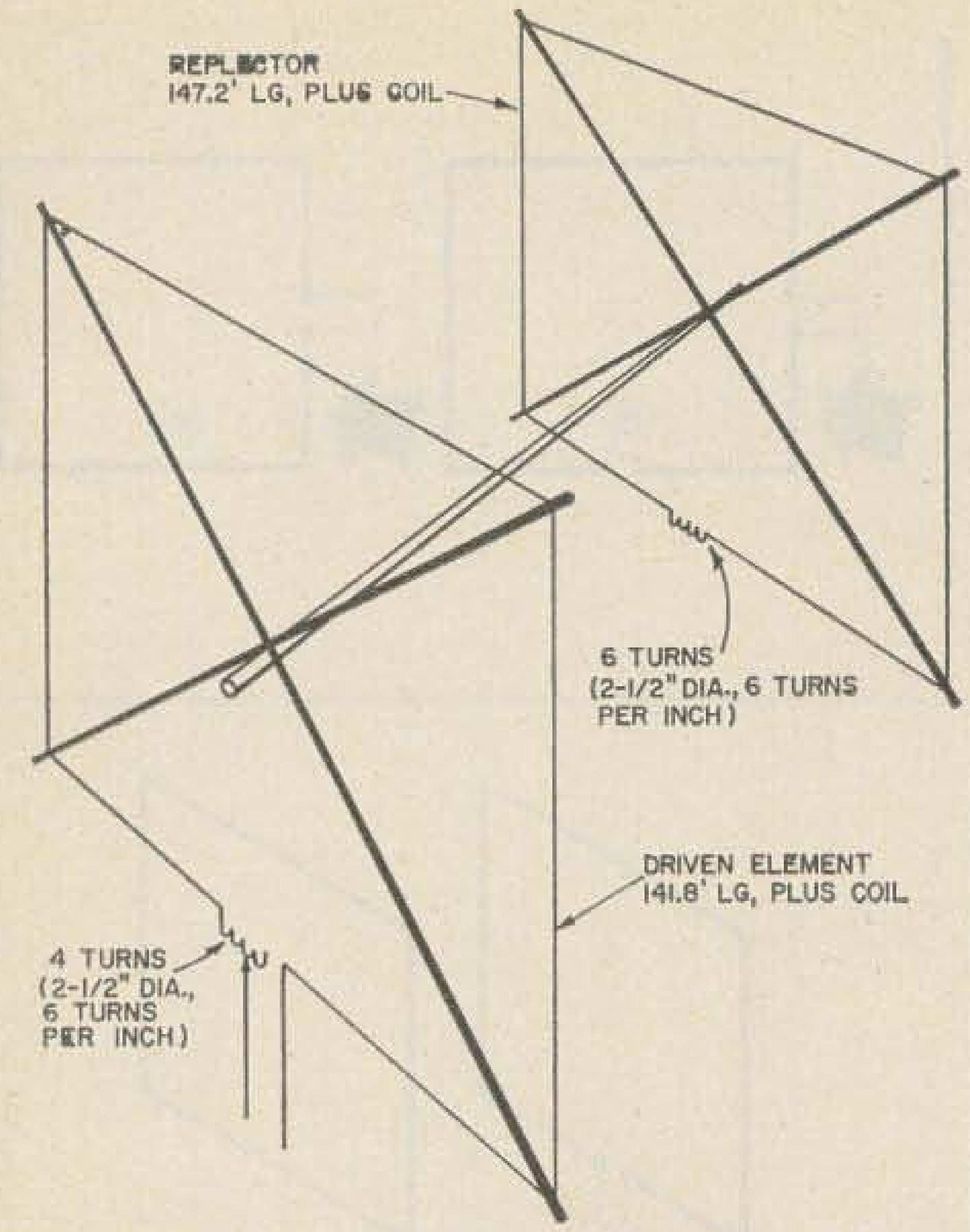
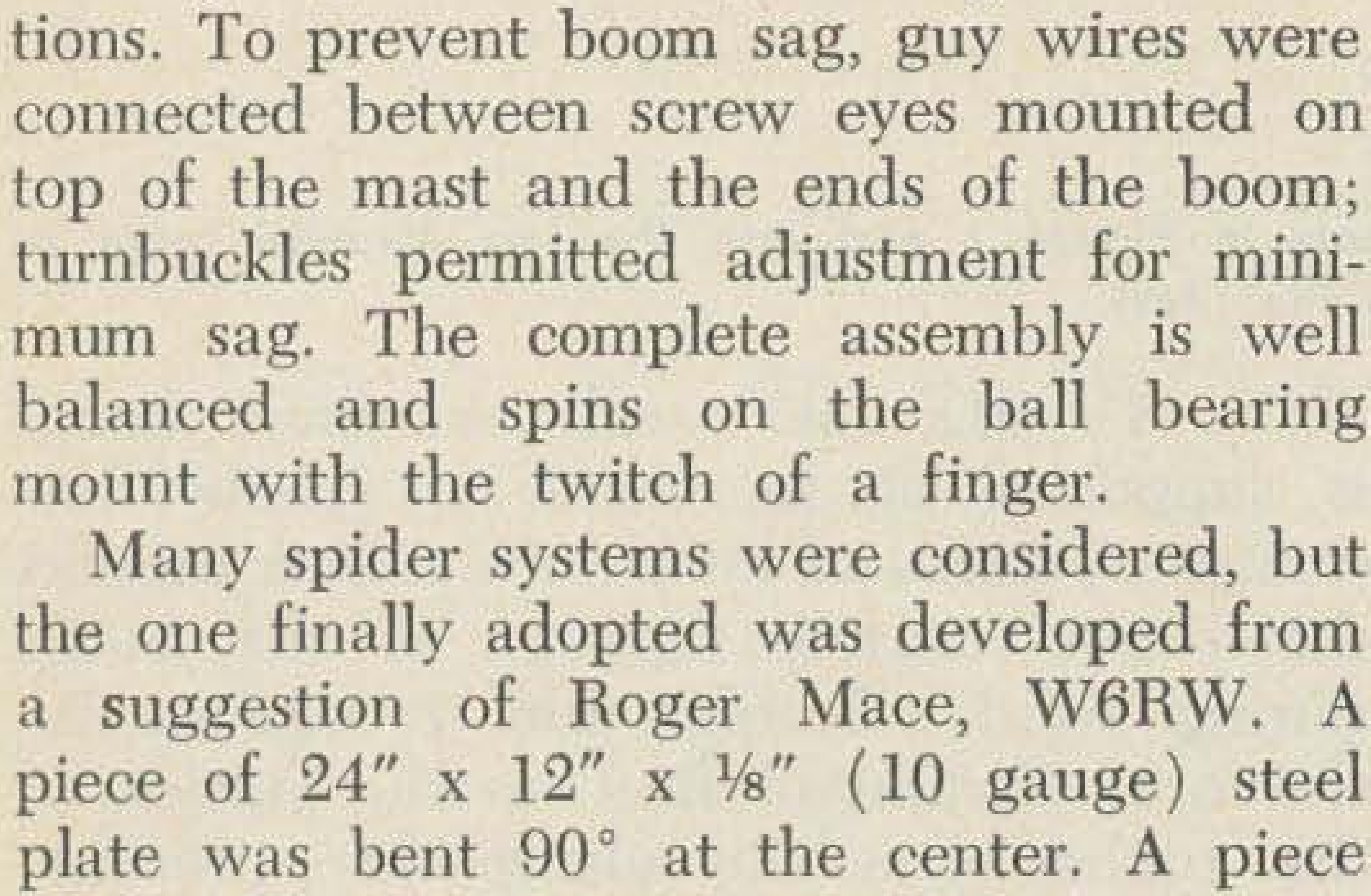


Fig. 2. The full size forty meter quad.

bolts going all the way through both sections. To prevent boom sag, guy wires were connected between screw eyes mounted on top of the mast and the ends of the boom; turnbuckles permitted adjustment for minimum sag. The complete assembly is well balanced and spins on the ball bearing mount with the twitch of a finger.

Many spider systems were considered, but the one finally adopted was developed from a suggestion of Roger Mace, W6RW. A piece of 24" x 12" x ⅛" (10 gauge) steel plate was bent 90° at the center. A piece of 4" ID water pipe was sliced into 1" wide rings; each of these was slit along one side. Two of these were welded to each plate as shown in **Fig. 4.**

On each side of the slits in these clamps an over-size nut was welded; a bolt could be run through these nuts to tighten the clamp snugly around the boom. Diagonal reinforcing bars of 1" x ¼" steel strap were added as shown in Fig. 4. Two holes drilled at the base of the plate accomodate U-bolts; a 3" length of 1" wide, ¼" thick angle iron is welded into the top of each plate flush with the 90° bend. Each section of angle iron has holes drilled in it for a U-bolt and was mounted so as to have one side flush with the other side of the angle plate as shown in Fig. 4. A thirty foot piece of 2" OD aluminum irrigation tubing was used for the central section of the support arms. Five-foot lengths of 1⅞" OD tubes are telescoped inside the ends of this piece. Twelve foot lengths of high quality bamboo* are telescoped inside the ends of the aluminum to give an overall length of about 56 feet. For maximum strength these bamboo poles should be wrapped with a layer of surgical gauze and coated with fiberglass.



Method of supporting the boom to the mast. This photo also shows part of the guy wire system used.

The tubing to tubing and tubing to bamboo joints are made as shown in Fig. 4. Sleeves of sheet aluminum are placed over the arms where theU-bolts will grip them. Good quality hose clamps may be obtained from an automotive supply house for the joints. About 6 inches from the upper tip of each piece of bamboo the wood should be wrapped with tape, a hole drilled and a small pulley tied on. These two pulleys support the upper corners of the wire square and permit it to be lowered for adjustments; nylon cord is used in the pulleys.

In order to prevent the spider arms from breaking in the wind they must be properly guyed. Holes were drilled in the two 1" straps welded across the bottom of the spider plates and at the tips of two 5 foot pieces of ¾" pipe; these pipes were bolted on as boom extensions. Nylon parachute cords run from the holes in the end of each boom extension to the tips of each of the four element arms. Three separate strands should be used in parallel for maximum protection. Likewise, four guys run from the other side of the element arms to an extra spider on the inner side of the boom (reserved for future additions). For further support of the arms, particularly when the wire square is lowered, nylon rope was run in a square around the bamboo arms 6 feet from their tips; the total arm guy system is shown in Fig. 5.

*Good quality bamboo will be shipped by the Sea and Jungle Shop, 4666 San Fernando Road, Glendale, California. They maintain a large stock of all sizes.

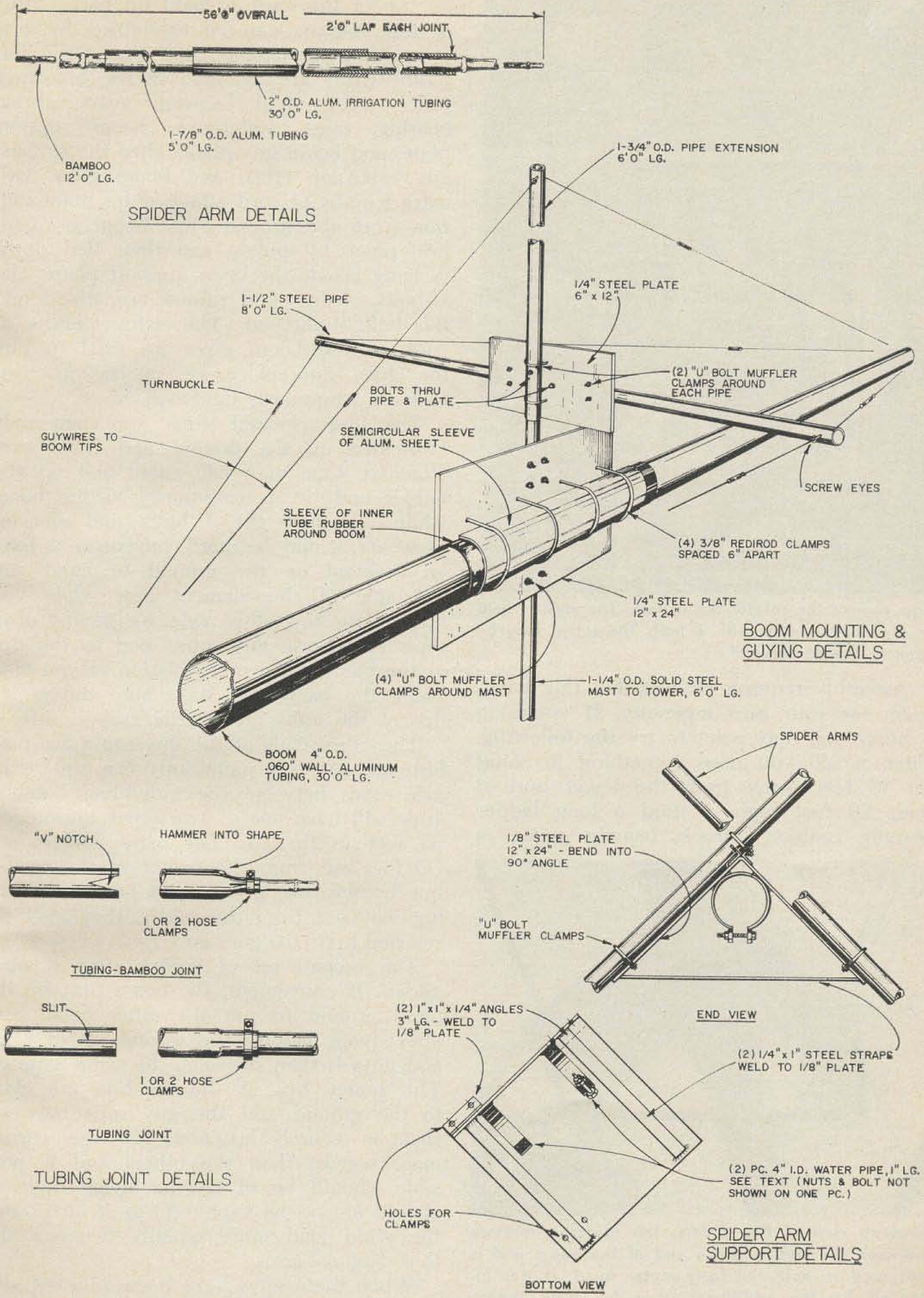
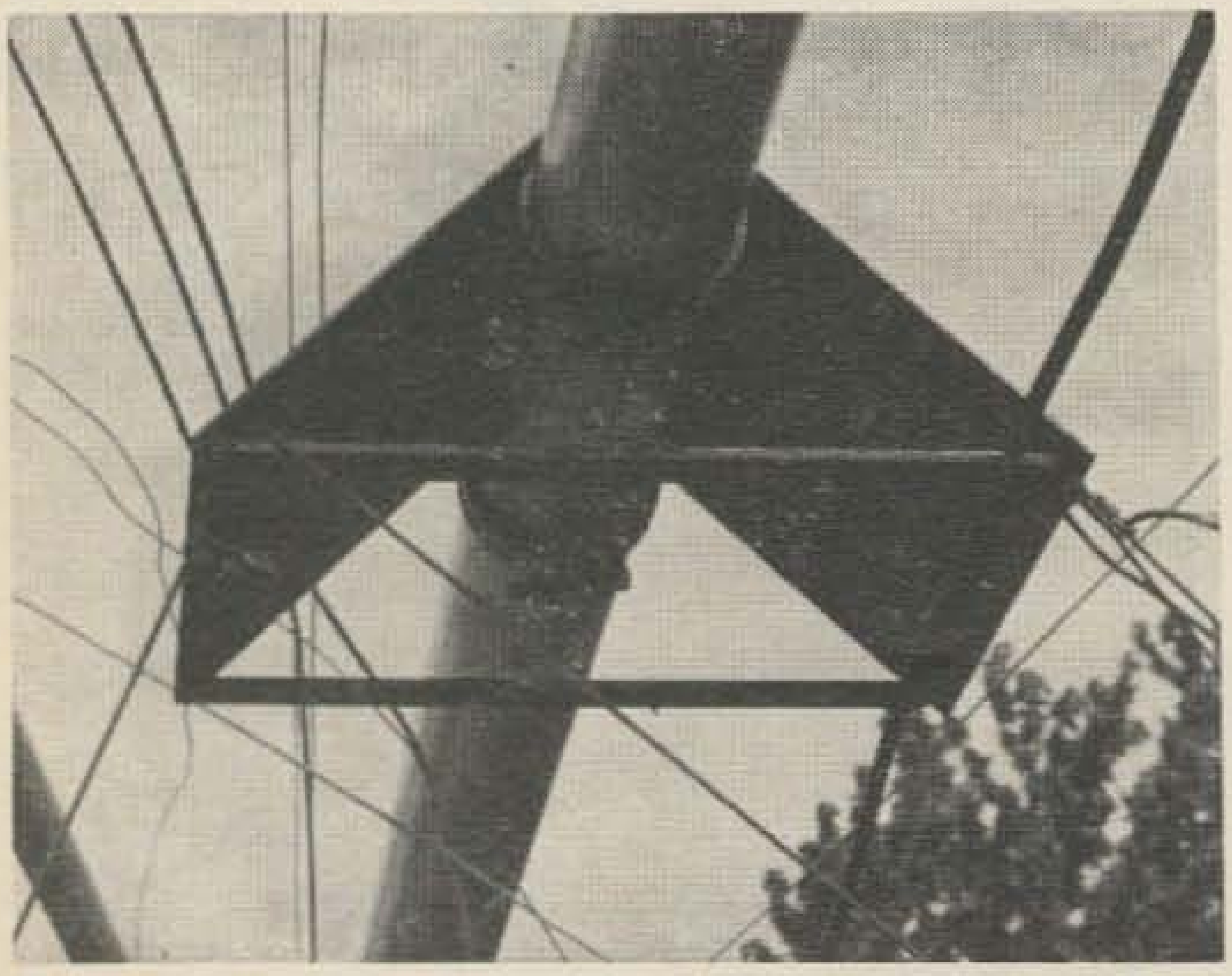


Fig. 4. Construction details of the forty meter cubical quad. This type of construction results in a light weight assembly that will withstand wind loading up to 60 mph.

Top view of the rotator mechanism. The mast is held in the slotted collar with a bolt. The selsyn may be seen in the foreground.

Assembly requires strategy but this leaves room for your own ingenuity. If you're in a hurry you may want to try the following. First of all, you need something to stand on 15 feet away from the tower and at least 20 feet high. I used a long ladder leaning against a truck, heavily guyed in each direction. A large pulley is placed on top of the mast to haul up parts. Most of the antenna can be assembled by one person but two people make it a lot simpler.



Closeup view of the spiders; this spider is midway between the mast and the end of the boom and is not used to hold the forty meter quad. It was intended for the additional of a full sized twenty meter quad at a later date. In the forty meter quad it serves as an anchor point for part of the guy wire system.

The items are mounted in the following order: rotor, ball bearing, gears, thrust bearing, mast, Rotobrake, boom support plate, and boom guy plate. Then the spiders, guy extension arms, and boom guys with extra lengths of cord attached for manipulation from the ground. The boom is raised into place by pulley and then tied down to hang beside the boom support plate. The U-bolts, sleeves and rubber are added and the bolts tightened. The extra lengths of cord on the boom guys are used to pull the guys into place for anchoring; then they are temporarily tightened.

The four element arms are completely fabricated on the ground and their guys attached. One man can carry one up the ladder and tie it temporarily to the boom while adjusting the U-bolts and sleeves. However, it may be more convenient to have an assistant on the ground to hand you one side of the element arm while you manipulate the other side by means of a rope (don't use guy ropes tied to the tips of the bamboo for manipulation or you may break the bamboo). Make sure the pulley tips of the arms are on the ground side.

The other ends of the guy ropes are now fastened. At this point only the square of guy ropes between the individual bamboo arms will have one or two ropes unfastened 35 feet in the air. The extra spiders are 7.5 feet out from the center of the tower, but by wearing a lineman's belt and leaning way out from the tower, they may be reached to tie the guys on.

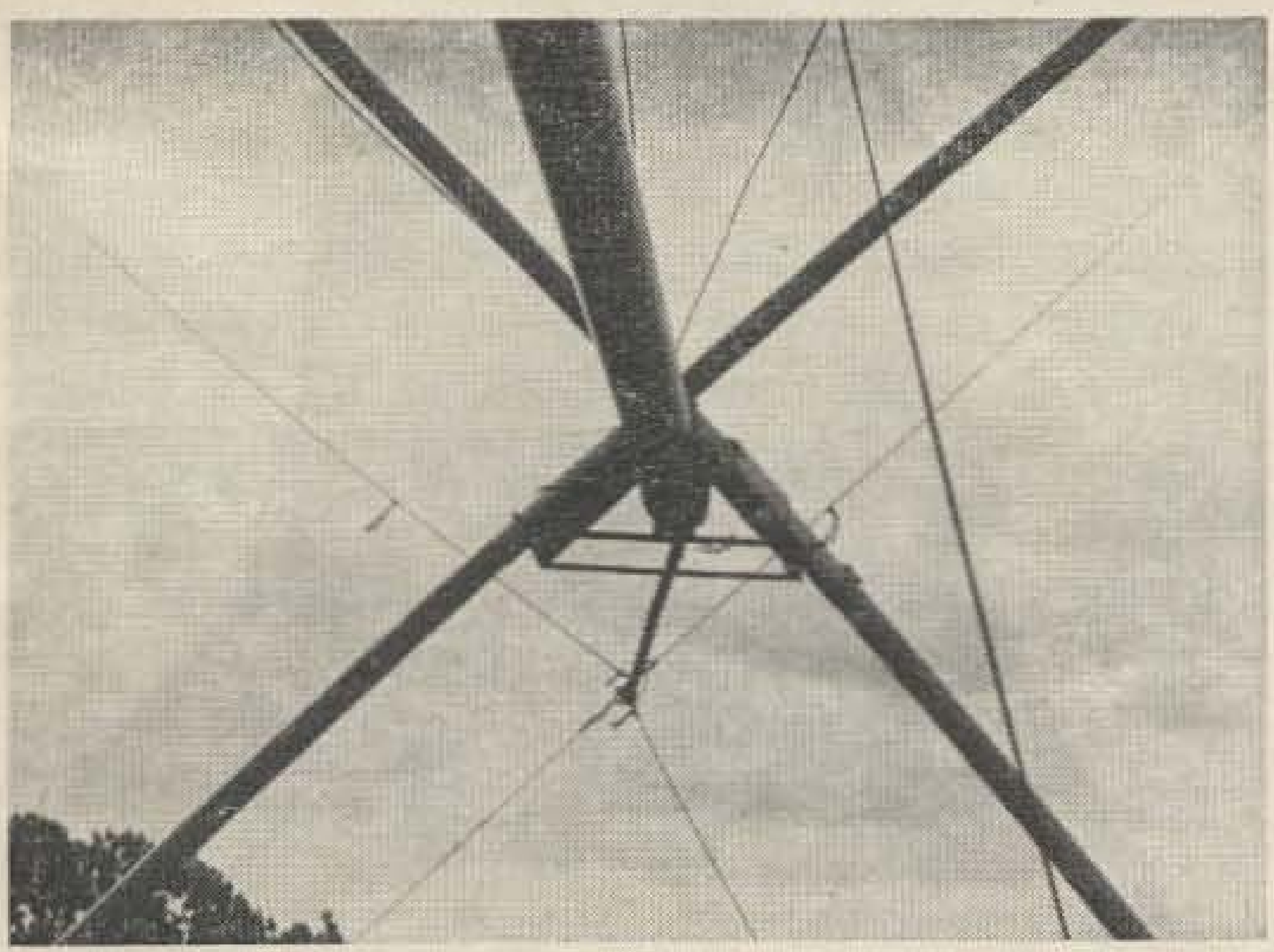
The second set of spider arms is now added. If convenient, the boom may be rotated around to put the other boom end above your ladder; the second set of arms and guys is then added in the same manner. The pulley tips of the bamboo are close to the ground and the guy rope between them is securely fastened. This guy carries more weight than the others and if possible, should be of heavier nylon rope. It should always be kept tight as it distributes the wind load more equally between the four diagonal arms.

When these guys have been adjusted and the other guys have been added to the pulley arms, the 4 boom U-bolts are loosened and the boom is rotated 180° on its own axis to put the pulley tips high in the air (if you have a derrick truck you can work on each part of the antenna without the need for boom rotation). The remaining guys are then fastened. The wire elements are prefabricated on the ground and may be pulled up with the pulley ropes and tied down. In my case it was found convenient to hang a nylon rope from the boom tip to support the heavy gamma match and RG-8/U coaxial feedline.

Considerable adjusting and tinkering was done with the elements after the antenna was mounted on the tower. The final dimensions include a coil at the bottom center of each element for length adjustments. Little efficiency is sacrificed by using coils and they are much more convenient than changing large lengths of wire. The dimensions of the elements are given in Table 1.

The resonant frequency was 7.0 MHz when the boom was 25 feet off the ground; at 56 feet the resonant frequency was 7.2 MHz with the following SWR across the land: 7000 kHz, 1.8; 7100 kHz, 1.4; 7200 kHz, 1.25; and 7300 kHz, 1.4. The resonant frequency shifted about 50 kHz during rotation due to proximity of nearby objects, but this was of little consequence because of the broadbanded nature of this quad. The gamma match uses two #12 wires 4.6 feet long and spaced 6 inches apart with plastic spacers; a series 200 pF capacitor was used to tune out the inductive reactance of the gamma match.

This quad gave very good results in the 1961 World Wide DX contest and 1962 ARRL DX contest. Africa was worked via long path and European hams were heard on the long path around 1400 GMT; DX worked included HV1CN, FB8XX, TU2AL, VK5XK/VK9, EP2BQ, VS9AAC, and ST2AR. The quad compared very favorably with full size two element beams of similar height in the USA but no local beams were available for comparison. JA's were worked one after another in the morning and stations running 5 to 20 watts from several continents had good 559 and 569 signals; Europeans have been as strong as 40 db over 9 on a 75A4. The quad consistently got very good signal reports and often, "First W9 on 7 MHz".



The spider supports used at the ends of the forty meter cubical quad.

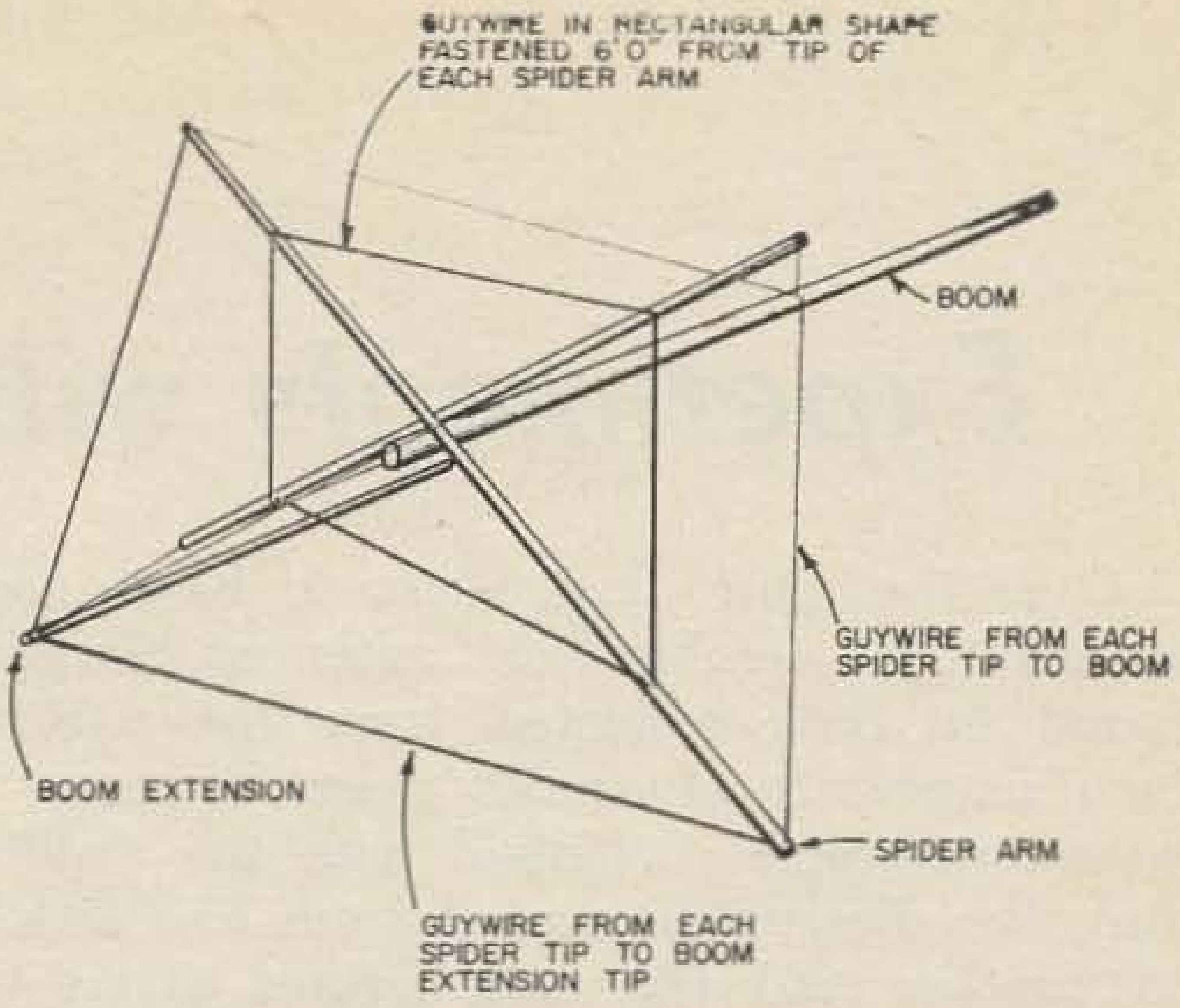


Fig. 5 Guying system used with the spider arms. Without this system the arms will break in winds of 30 to 40 mph.

The front to back ratio runs from 5 to 40 db depending on the direction, angle of radiation and skip characteristics. Numerous observations of 7 MHz broadcast stations and hams showed average gains of two S-units or better over a 1000 foot longwire aimed at Europe. Nearly all work has been on CW with 900 watts, but with a borrowed SSB exciter all continents except Asia were easily worked.

The antenna has stood up well in 50 to 60 mph winds, snow, and ice as long as all guys were kept tight; if the guys are not tight the arms will break in winds of 30 to 40 mph. This antenna is a joy to operate with on 40 meters, but you must take a bit of time to build and maintain it.

I wish to express my appreciation particularly to my tolerant landlady, Mrs. Ellen Richardson, to Alice and Otis Onsrud (Mr. Onsrud contributed the expert welding), Tom Leffingwell, and Donald Weinshank. Also to W4VRD, W6RW, K9ELT, K9KNC, W9SZR, and to all the others who have helped.

. . . K6DDO

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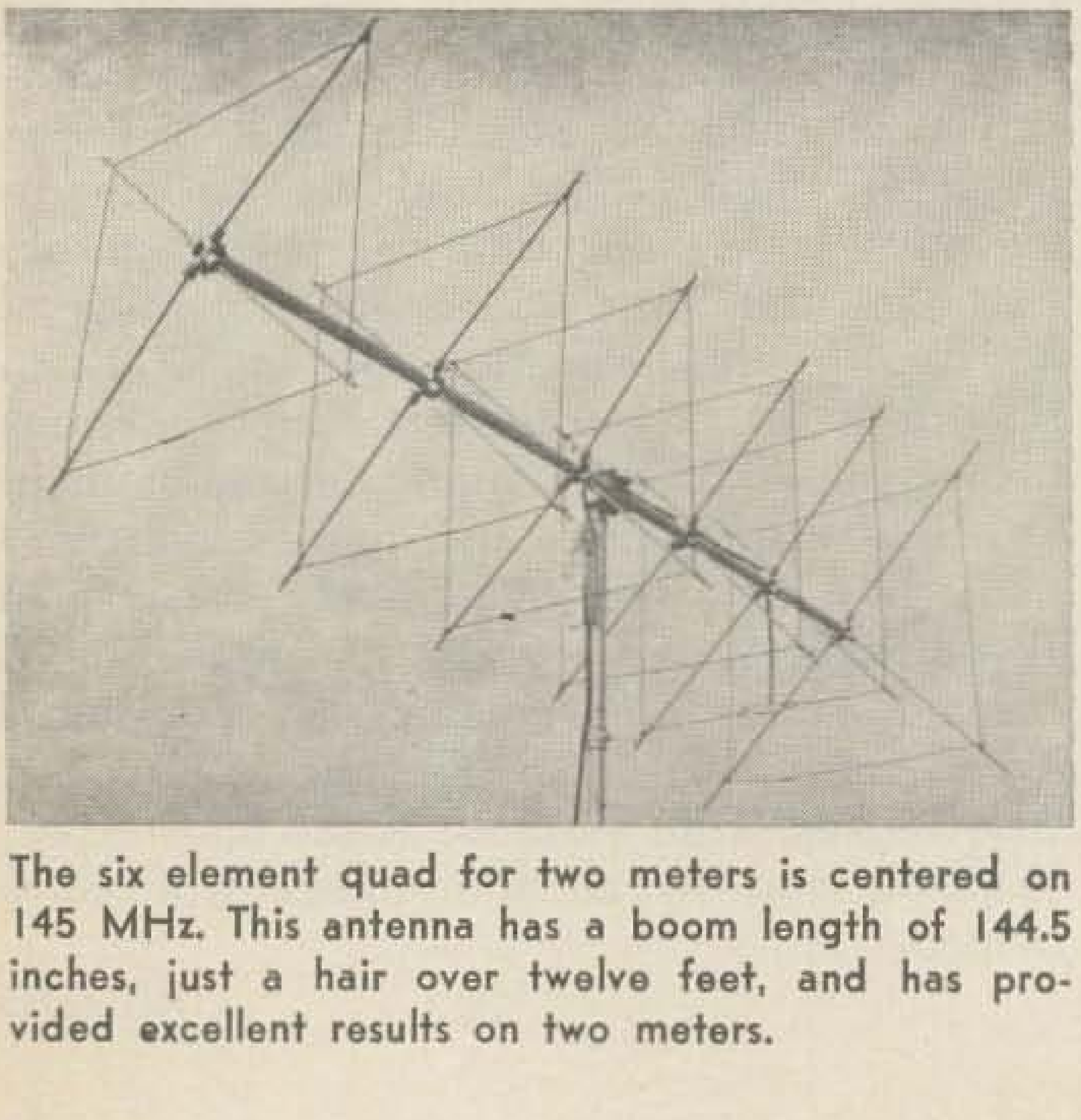
Experiments with Quad Antennas

Over the past few years I have constructed a number of antennas, largely based on data collected from the various ham magazines. In most cases however, I wasn't completely satisfied with the results; also, the dimensions varied from one article to another and the gain figures given by the authors seemed to be somewhat excessive.

I decided that the only way I was going to get a proper answer was to conduct a little basic research. With the few instruments that I have at my disposal, and a lot of cut and try, I think I can now provide some useful information on the construction of cubical quad antennas.

My first experimental quad antenna was designed for 145 MHz. This antenna was designed in such a way that I could vary the dimensions, spacing and height from the ground. Since I didn't have a lot of exotic antenna testing equipment, I made do with what I had. The resonant frequency of the elements was found with the aid of a grid-dipper and a communications receiver; the front-to-back ratio, minimum radiation angle and attenuation off the sides of the antenna were determined with three separate field strength meters. In addition, an antennascope was used to measure the input impedance to the quad and an SWR meter used to check the match.



The six element quad for two meters is centered on 145 MHz. This antenna has a boom length of 144.5 inches, just a hair over twelve feet, and has provided excellent results on two meters.

With this simple test equipment I closely examined a three element quad for two meters and the effects of element spacing, height above ground and various elements dimensions. To insure that the results were not just casual but repititive, the tests were conducted over a three month period and have been repeated three times; in each case the entire antenna was completely disassembled and re-assembled. After I had completed all the tests on the 145 MHz quad, I used the experimental data to develop a three element three band quad for 14, 21 and 28 MHz.

Obviously, to construct an antenna for three different bands, I had to make compromises to obtain optimum results on all three bands. During the course of my experimentation I was able to establish that when a reflector was adjusted by means of a stub on the lower part of the square, the antenna became asymmetric and lost considerable gain in the horizontal plane. Therefore, two stubs should be used to adjust the reflector and other parasitic elements; one on the upper side of the reflector and one on the lower side. In addition, these two stubs should be adjusted together. This solution practically precludes adjusting an antenna for 14, 21 and 28 MHz, so I completely removed the stubs and made all the sides of the quad perfectly symmetrical. I also found in the course of my experiments that the alignment between the wires of the various elements is very important.

After completing the experiments with the model antennas, I built a full size three element quad for 14, 21 and 28 Mhz. This antenna has been placed on a support projecting 5 meters (about 16½ feet) from the roof of my house. This antenna is fed with a single transmission line; two relays mounted in a water-tight box switch in the proper radiator when I change bands. It is highly advisable to use a ¼ wavelength of transmission line (or an odd multiple) between the relay switch box and the radia-

Quad Dimensions

Total Length of Wire used in each element

Band	**10 Meters**		**15 Meters**		**20 Meters**		**2 Meters**	
Reflector	1079 cm	(424.8 in)	1470 cm	(578.7 in)	2204 cm	(867.7 in)	216 cm	(85.0 in)
Radiator	1029 cm	(405.1 in)	1403 cm	(552.4 in)	2103 cm	(828.0 in)	206 cm	(81.1 in)
Director	978 cm	(385.0 in)	1333 cm	(524.8 in)	1997 cm	(786.2 in)	197 cm	(77.6 in)

Spacing between elements: on the tri-band beam for 10, 15 and 19, and 20, the director is spaced 260 cm (102.4 in) from the radiator; the reflector is spaced 230 cm (90.6 in) from the radiator. For the six element two meter quad all spacings are in reference to the radiator and are as follows: reflector, 31 cm (12.2 in); 1st director, 29 cm (11.4 in); 2nd director, 63 cm (24.8 in); 3rd director, 96 cm (37.8 in); and 4th director, 148 cm (58.3 in).

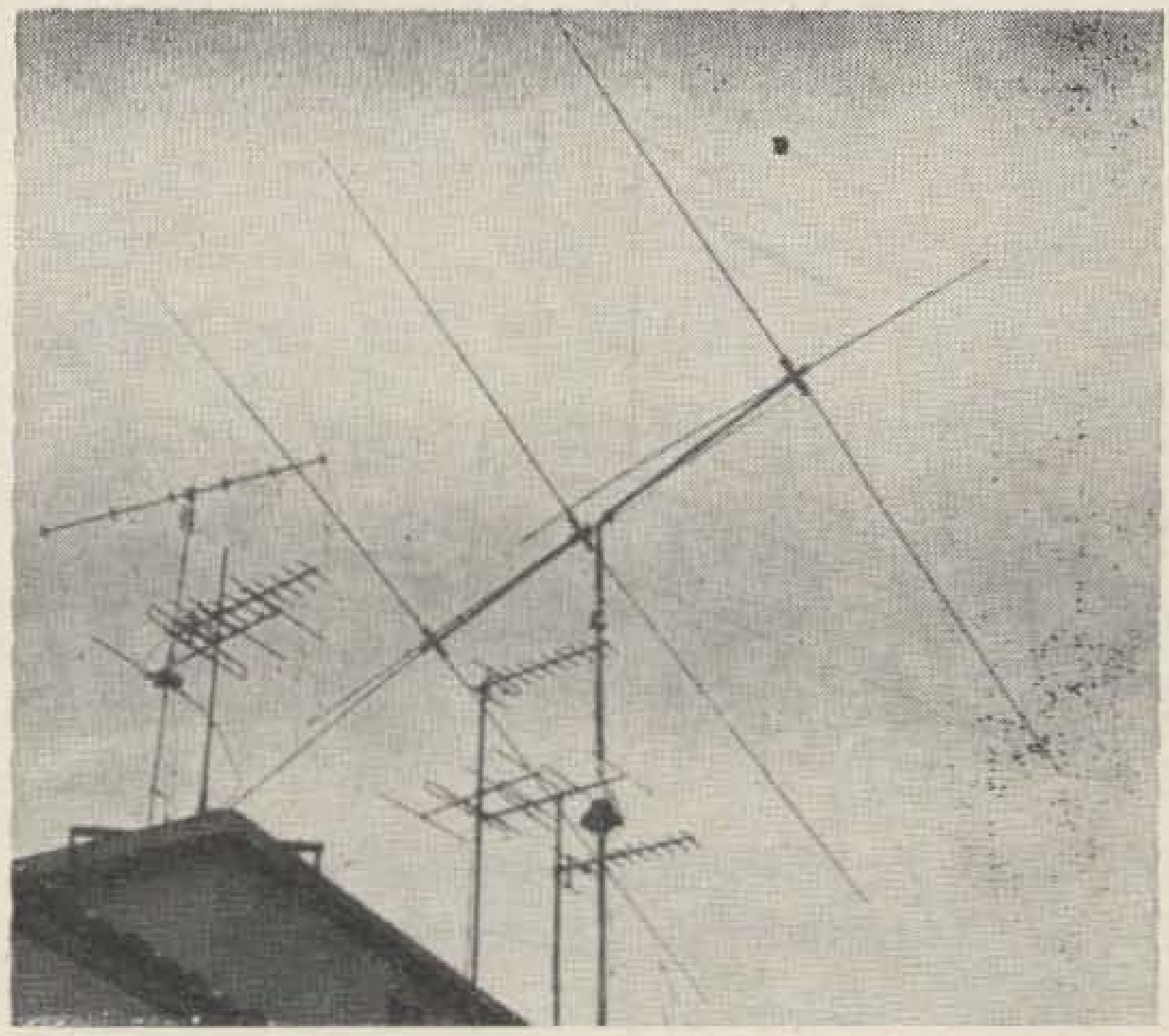
tor element. You definitely should *not* tie the three radiator squares together to facilitate feeding by a single transmission line; the gain and directivity are completely destroyed.

Mechanically the beam was constructed by using a boom of extra-light steel tubing on which three cast aluminum cross-pieces are threaded. Bamboo poles were used to support the wires. At the points where the wire squares are fixed, stainless steel springs have been mounted to keep the wires taut and in alignment without subjecting the bamboo supports to flexing. These springs also compensate for the lack of symmetry of the poles after they are mounted on the boom. After the wires and stainless steel springs were mounted, all the bamboo poles were given a coat of protective paint.

Where the poles are attached to the cross-arms, a small sheet of thin rubber 6 mm thick (about ¼ inch) has been inserted to make the joint more elastic. The poles are then fixed in place with galvanized U-bolts. The preparation of the wire squares requires the utmost in accuracy; the data shown in the following tables should be followed as closely as possible. The easiest way to accomplish this is to unwind the wire, measure a length 20 cm long (8 inches), form a small eyelet in the wire and solder it so it provides a reference point for the subsequent eyelet. Each side of the square is carefully measured until the whole square has been made; the first length of wire is used to close the last side with a solder joint. Close attention to this procedure greatly facilitates the final assembly, and permits easy installation of the eyelets at the corners over the stainless steel springs. The same method may be used for the construction of a 144 MHz quad, but for the two meter version the bamboo should be replaced with a material that has better rf characteristics.

The results obtained with this antenna are best illustrated by comparing it to a multi-band commercial unit. The front-to-back ratio is not maximized because of the compromises made in dimensions to permit optimum operation on three bands. However, on 20 meters the front-to-back ratio is on the order of 22 dB. The vertical angle of radiation appears to be lower than that of a two element quad, but unfortunately, comparative tests are difficult to evaluate in terms of radiation angle and front-to-side ratios. The actual operating results have been excellent; with only 16 watts input on 14, 21 and 28 MHz, I have had excellent results working DX stations.

I have also been extremely pleased with the results obtained with the six element two meter quad; this antenna has consistently out-performed large commercial antennas installed by local amateurs.



The three element quad for 10, 15 and 20 meters. The SWR on all bands is less than 1.5:1, even at the band edges. On 14.00 and 14.35 MHz for example, the SWR is 1.4:1, at 14.18 MHz it is 1.2:1; at 21.00 and 21.45, the SWR is 1.2:1, at 21.23 it is 1.1:1; and on 28.2 and 29.5 the SWR is 1.4:1, at 28.8 it is 1.2:1. SWR checks with both Heathkit and Jones Micromatch bridges provided almost identical results.

. . . I1RR

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The Half Quad Antenna

A muscular version of the inverted V dipole

Thirty some odd years ago, E. J. Sterba developed a form of stacked dipole antenna which bears his name. Although the Sterba curtain is not too popular with radio amateurs, it is, none the less, an excellent antenna. The Sterba, as you no doubt know, is the grandaddy of some antennas that enjoy great popularity today.

The lazy H, a simplified version of the Sterba in its basic form, is one of the descendants of the Sterba, and was introduced to the amateur world by W6BCX. From the lazy H, the same gentleman, W6BCX, developed the bi-square by combining the half wave elements in the form of a square. The bi-square dimensions, particularly at the lower frequencies, become rather ungainly mechanically, so it was inevitable that someone would find a way to reduce the size of the half wave sides and still retain reasonably good gain. We know this reduced size bi-square, with one quarter wave length sides, as the cubical quad. Now, let's take the quad and reduce it in size by slicing it in two, leaving only the top half. This remaining half, for want of a better name, becomes a half quad.

The main advantage of the half quad is that it can be erected for the 40 and 80 meter bands without resorting to the use of broadcast station size towers. The half quad employs wire elements, supported in

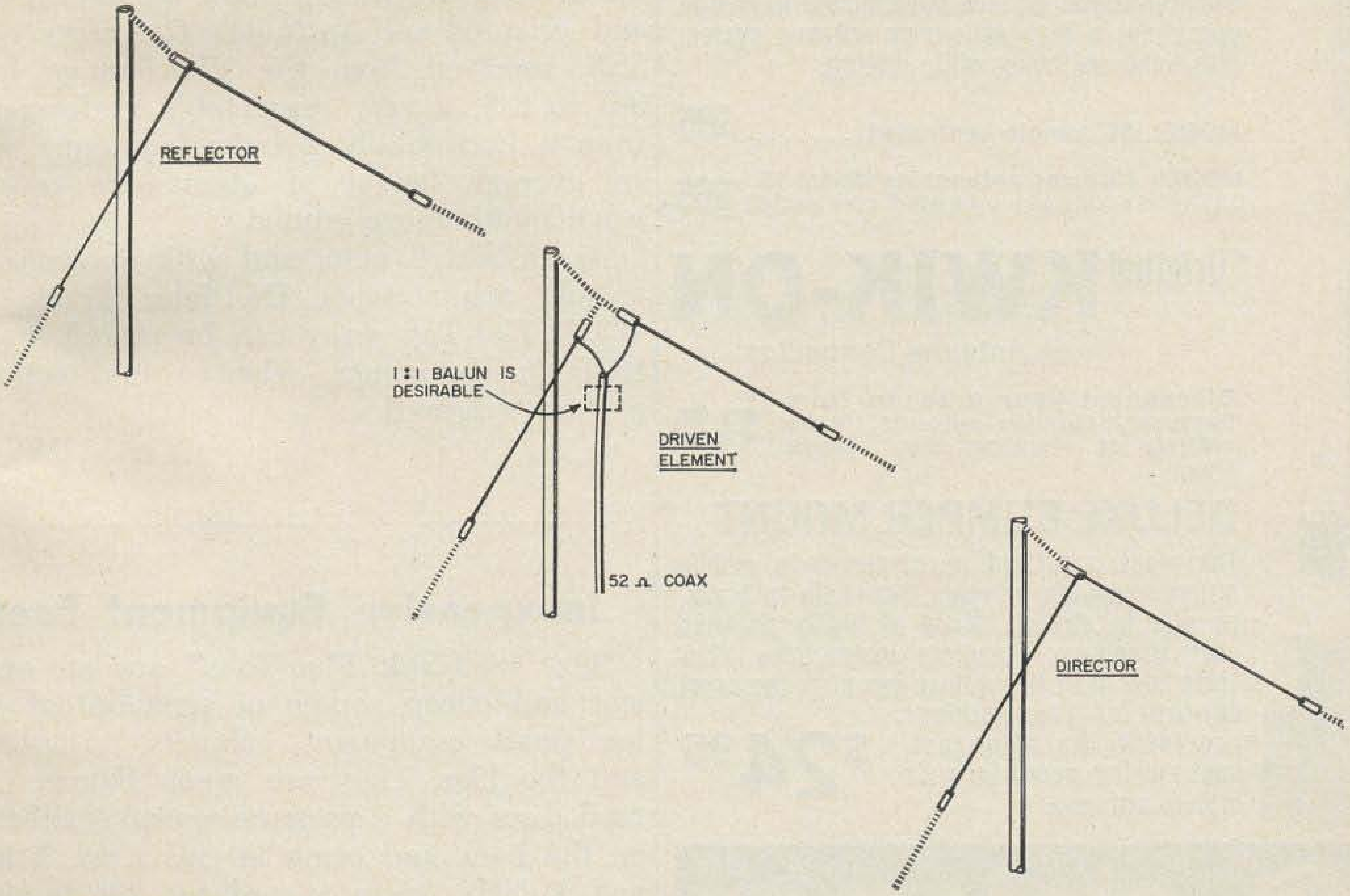
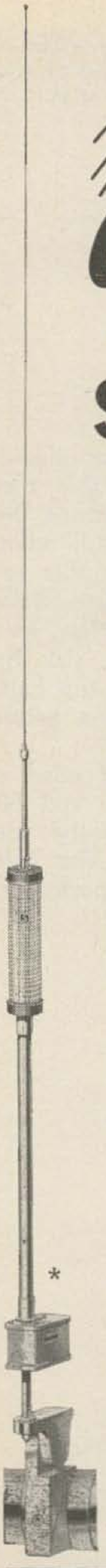


Fig. 1. W0SII's half quad antenna.



Half Quad Dimension

Half Quad Dimension

	7.1 MHz	7.2 MHz	3.8 MHz	3.9 MHz
Reflector	69'10"	68'3"	129'2"	126'
Driven Element	66'	65'	123'	120'
Director	62'8"	61'3"	106'10"	114'

One quarter wave length, for element spacing, (In Feet) = $\frac{246}{\text{Freq (MHz)}}$

the center with a single pole. The elements are slanted down toward ground at an angle of approximateliy 45 degrees (See **Fig. 1**). The parasitic elements are attached to the poles with small insulators, and the driven element is constructed and attached to its pole in the normal inverted "V" fashion.

The two or three element version of the half quad, with one quarter wave spacing between elements, will give good gain and allow the array to be fed directly with 52 ohm coax cable. With one quarter wave length spacing, the feed impedance of the half quad, using the two element version with a driven element and reflector, will be about 60 ohms. The three element half quad will give a feed point impedance of approximately 30 ohms. The gain of two element half quad is 4.5 dB, and for the three element half quad, 8 dB.

The half quad at this QTH is the 40 meter size, suspended from 50 foot poles, and oriented on Australia. The reports on SSB, received from the VK's, range from S-5 to S-8, a very respectable performance from a horizontally polarized antenna with an average height of about one quarter wave length above ground.

As an added note, and with apologies to an old acquaintance Dr. John Kraus, the W8JK Flat-Top array can be rigged in the Half Quad manner, when a bi-directional pattern is desired.

. . . W0SII

Inexpensive Equipment Feet

The "Self-Stik Flan-Tabs" are an excellent and cheap source of scratchproof *feet* for small equipment cabinets, mini-boxes and the like. They are green flannel covered discs with a pressure-sensitive adhesive on the back and come in two sizes, ⅜ inch and ¾ inch, 32 to a card for 29c in dime stores.

. . . Edwin Hill W3URE

James Allender K8YIB
James Navarre K8DYZ
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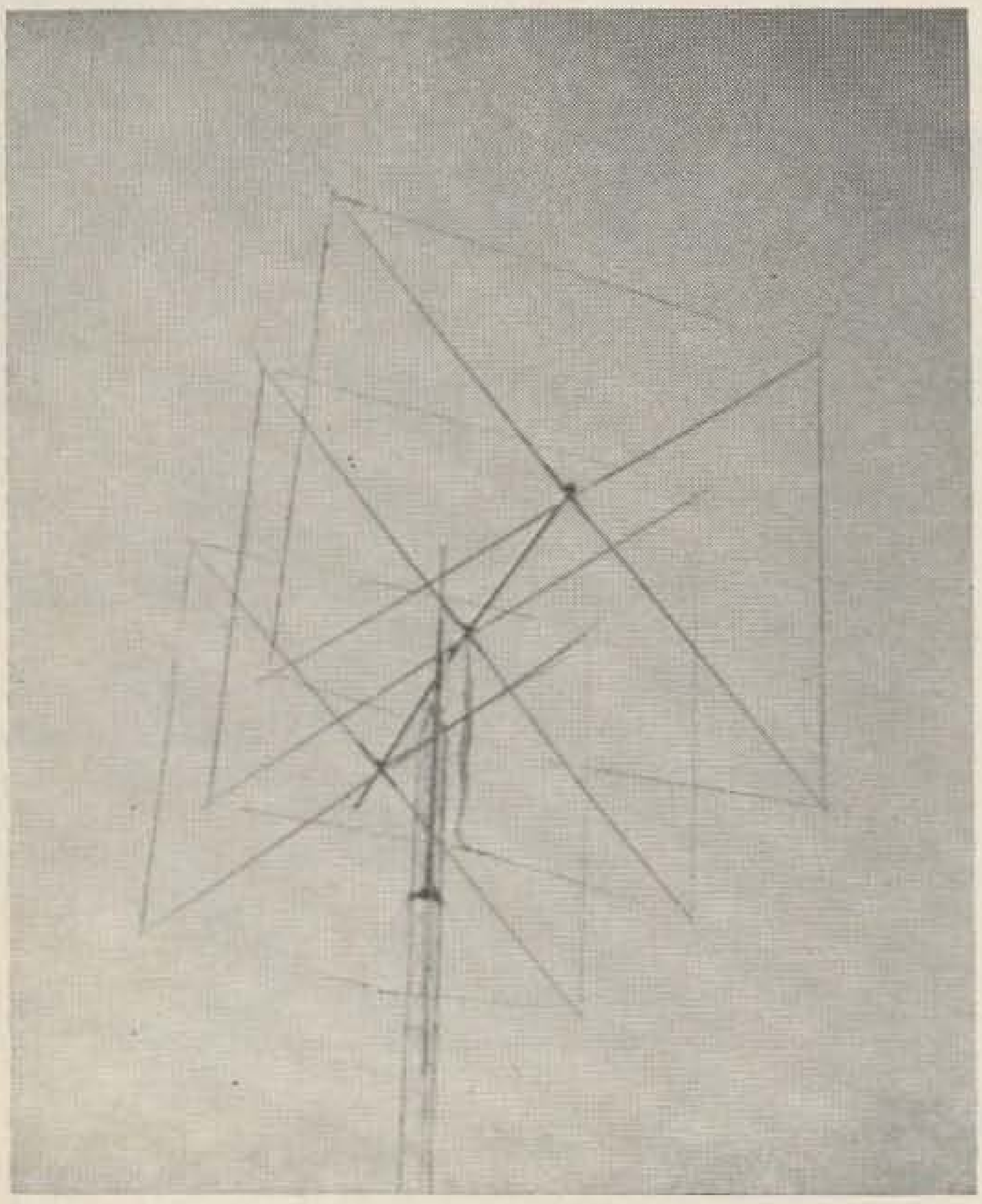
Davison, Michigan

The Three Element Quad

It is certainly not an "old wive's tale" when someone speaks about the performance results of the two element cubical quad. The gain is comparable to that of a three element yagi. From personal experience, the front-to-back ratio ranges from 25 to 30 dB, with the front-to-side ratio reaching as much as 40 dB. For the size of the antenna it packs a mighty punch in the roughest of pile-ups, and amateurs around the world will attest to its performance. Another favorable aspect of the quad is the relatively low construction cost.



The three element quad as seen from K8YIB's house shows the director, the driven element, and the reflector. The boom consists of three inch irrigation tubing and the spreaders are bamboo.

As we all know, most amateurs are never satisfied with their antenna, so we decided to go one better, and try a three element quad. There was very little information available on this type of antenna, nevertheless the problem of design and construction was undertaken.

Design

The dimensions for the three element quad were taken from W0AIW's dimensions for his four element quad. It was thought that we had to start somewhere, and Lee's figures looked good. Originally the boom length was twenty-five feet, but after running some tests on the air with local and out-of-state stations, it was decided that the front-to-back ratio was suffering badly. Thanks go to WA0IOR, Hal, whose suggestion to shorten the boom length was a great help in the final success of the antenna.

Construction

Spreaders: Fiberglass poles make excellent, durable spreaders, but are guite expensive. Bamboo poles also suffice, but do not weather well unless they are protected. A few coats of Spar varnish will last several years, but if the poles are fiberglassed, they will last indefinitely. Fiberglass resin and fiberglass cloth are available at most boat centers and sport shops. The bamboo poles were cut to a length of thirteen feet, and wrapped from the small end to the butt with three inch wide fiberglass cloth. About half a quart of resin was mixed at a time, and applied with a paint brush. About two days are required for the poles to dry.

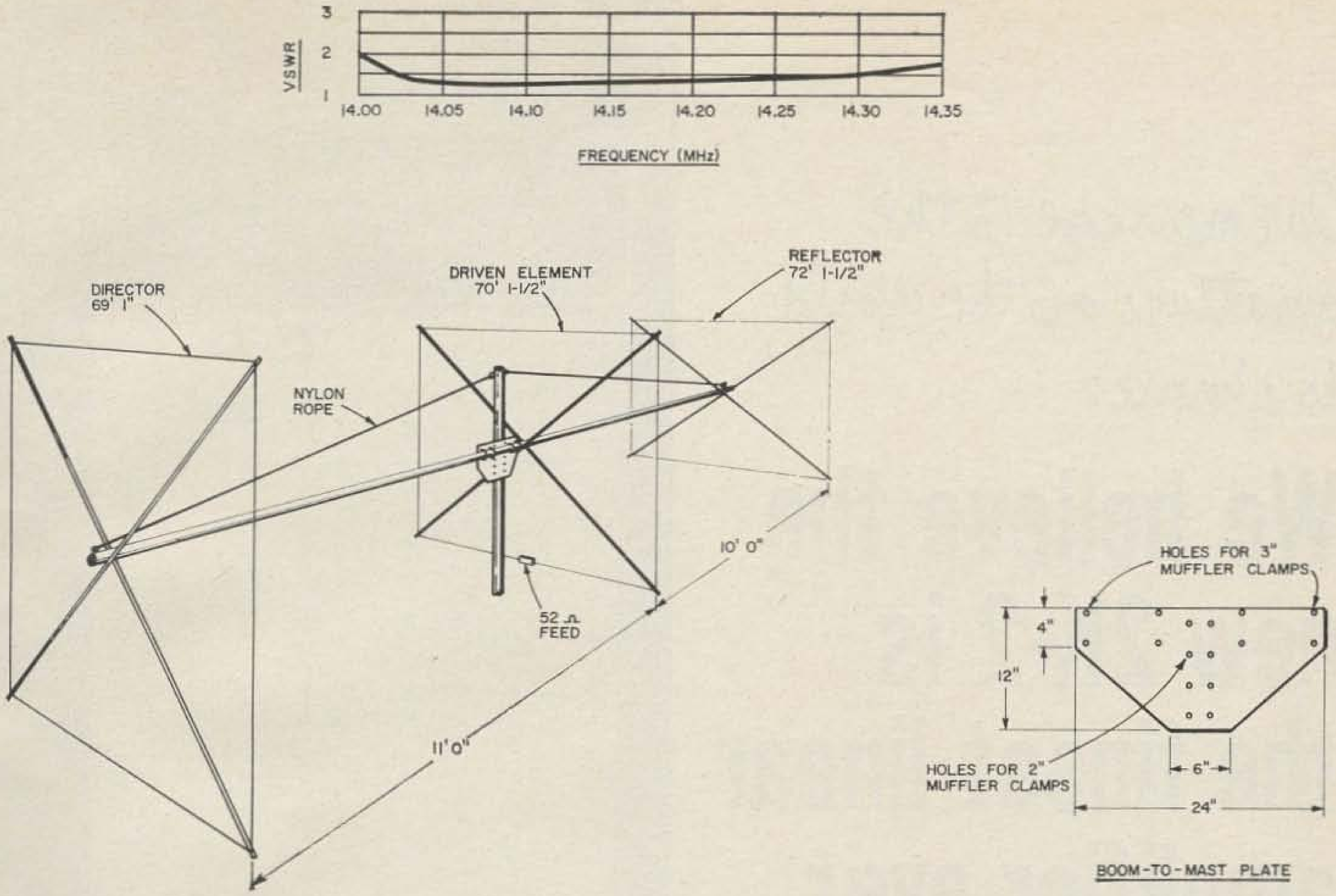
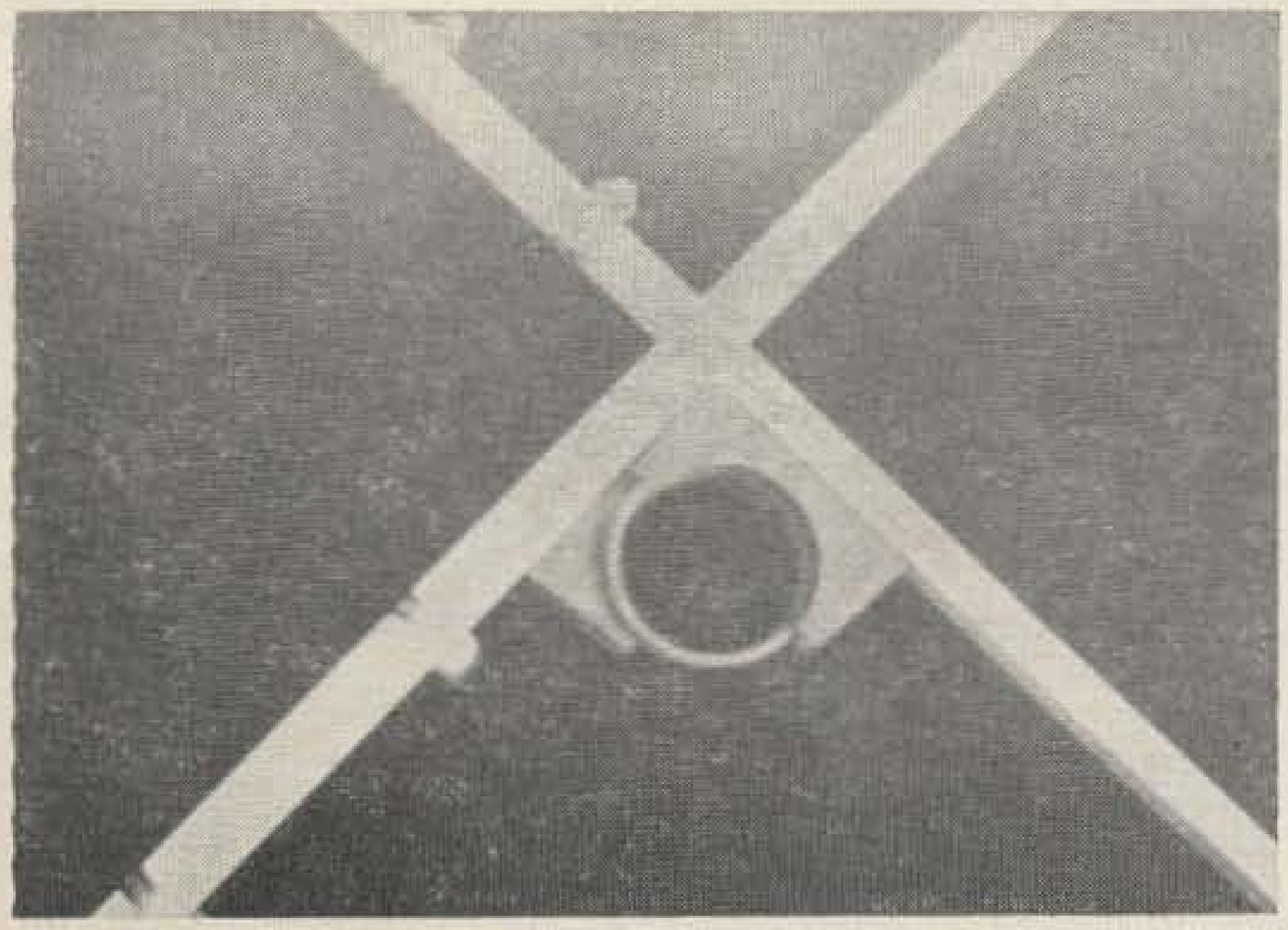


Fig. 1. This three element quad for twenty meters provides extremely wide bandwidth as indicated by the low SWR throughout the band. The construction of this quad is straight-forward and only requires a boom length of 21 feet.

Supporting crossarms: Three foot sections of one inch angle aluminum were used to hold the poles to the boom. The muffler clamps used between the angle stock and the boom are three inch. The bamboo poles are held to the angle aluminum by one and a half inch hose clamps.

Boom: The boom consists of twenty-one feet of three inch irrigation tubing. The spacing from the reflector to the driven element is ten feet, and the distance from the driven element to the director is eleven feet.



The supporting crossarms.

Stringing the elements: Number fourteen wire was stretched out and marked at 69′ 1″ for the director, 70′ 1½″ for the driven element, and 72′1½″ for the reflector. After the crossarms had been assembled, the spreaders were staked out perpendicular to each other, and each element was strung.

Assembly and tuning: Each element was fastened to its respective position on the boom, and 52 ohm cable was attached directly to the driven element. Tuning stubs were fashioned out of #12 wire and fastened to the director and reflector. The antenna was raised to approximately twenty feet, and the stubs were adjusted to give maximum s-meter readings on a receiver beneath the antenna.

Repeated comparisons with a nearby station, on the long and short haul DX, seem to indicate that the three element quad is comparable to his four element yagi. The front-to-back and front-to-side ratios are as good if not better than the two element quad.

Over 200 countries have been worked in the last six months, and good success has been experienced in the pile-ups.

. . . K8YIB

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A Light Four Element Quad for 20 Meters

Now that Spring is here it's time to think about improving your antenna system.

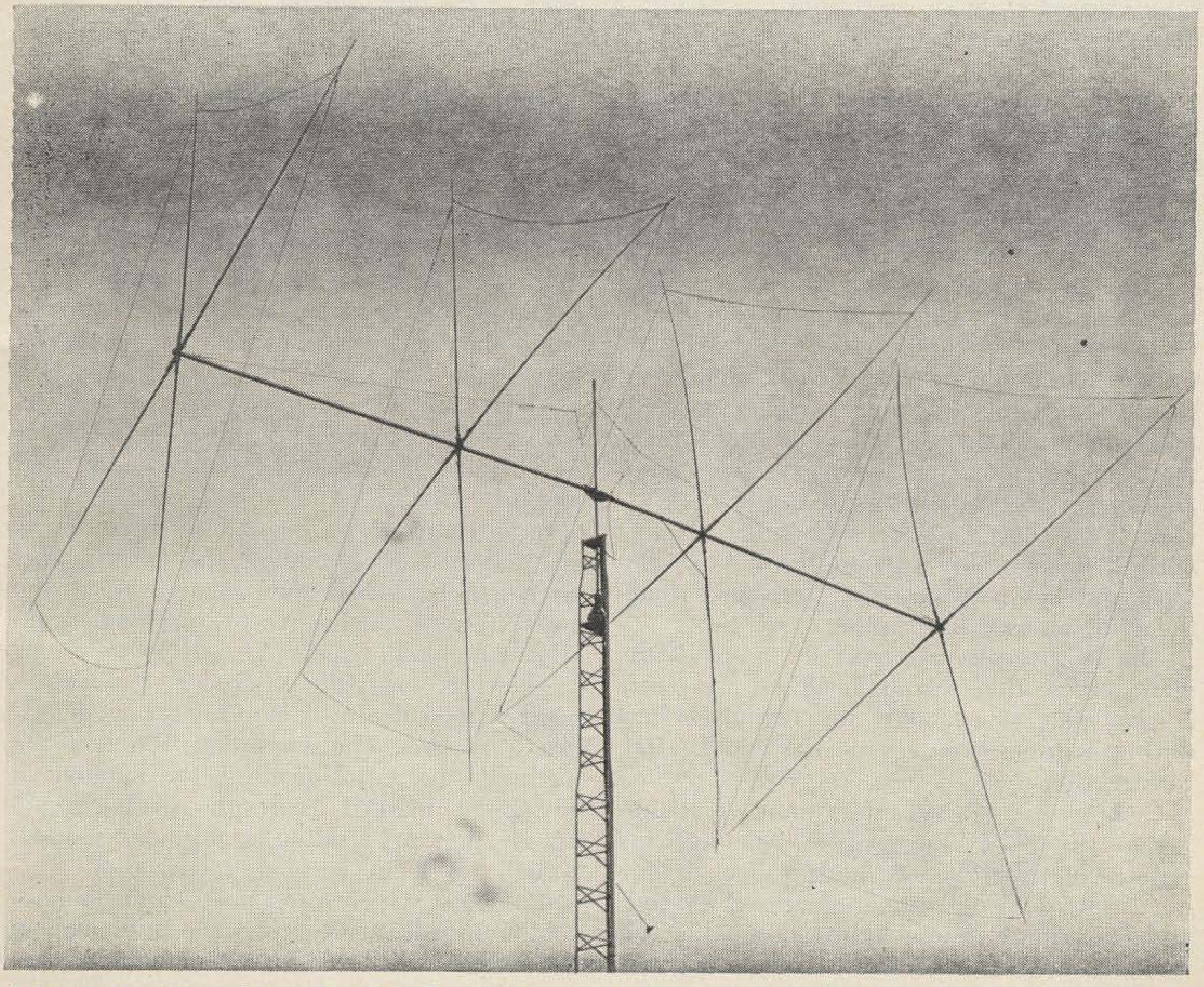
Why the antenna and not the transmitter?

Well it's easier to increase power in the antenna than it is to improve output power in the transmitter.

For example: If one ham in town puts up a quad that gives 10 dB gain, then another ham in the same town would have to increase his output power 10 times to get the same signal report. A 100 watt station using this same antenna would be as strong as his neighbor running 1,000 watts to a dipole.

A recent survey among leading DXers in the world shows that the six element beams and the four element quads put out the "big" signals.

Most people don't have the room or the money to put up a six element beam but



A four element quad for 20 meters. This antenna weighs less than 50 pounds and has withstood winds up to 80 miles per hour.

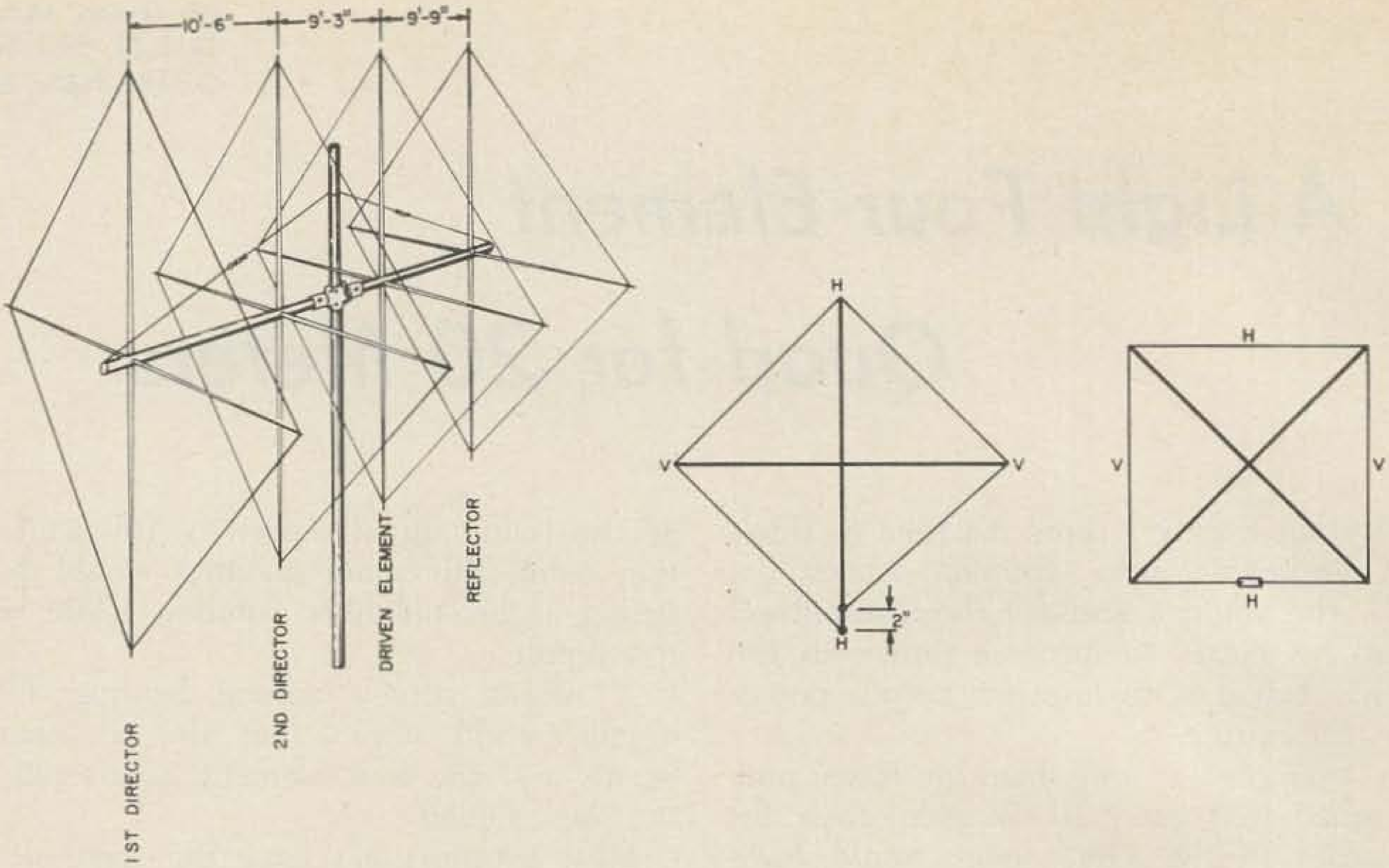


Fig. 1. Overall view of the four element quad for 20 meters; the total boom length is nearly 30 feet. Either diamond or square construction may be used as shown on the right, but the square model requires insulators—one in each element.

a four element quad doesn't take too much space and is considerably cheaper than the beam.

In the past, four element quads have been bulky, very heavy and parts were hard to come by. Today a four element quad can weigh under 50 lbs. By using lightweight fiberglass arms (16 of them) each weighing only a pound and by using a lightweight aluminum boom and using aluminum braces to mount the arms to the boom all totals up to a lightweight four element quad that can be supported by most towers capable of supporting a tri-band beam.

A 2" x 30' x .065 wall tubing spec. 6061ST-6 boom will support the lightweight arms and has a lower wind resistance than the 4" boom used in the past.

The least expensive arms for a quad are made of wood or bamboo. These arms can crack, split, warp and are easily broken during construction or by the wind after construction.

Commercial fiberglass is now available within the price range of the average income. This fiberglass is made especially for quad antennas and is manufactured by several companies. These lightweight arms sell for about $5 each or $80 for the 16 arms.

Quad arm mounts are also available for around $5 each or $20 for the 4 mounts.

Boom to mast clamps are available but be sure that they are big enough to support a four element quad. The support should be 12" x 2" O.D. for the boom and 6" x 1½" O.D. for the mast. The clamp on your old antenna might do the job or order one from an antenna manufacturer.

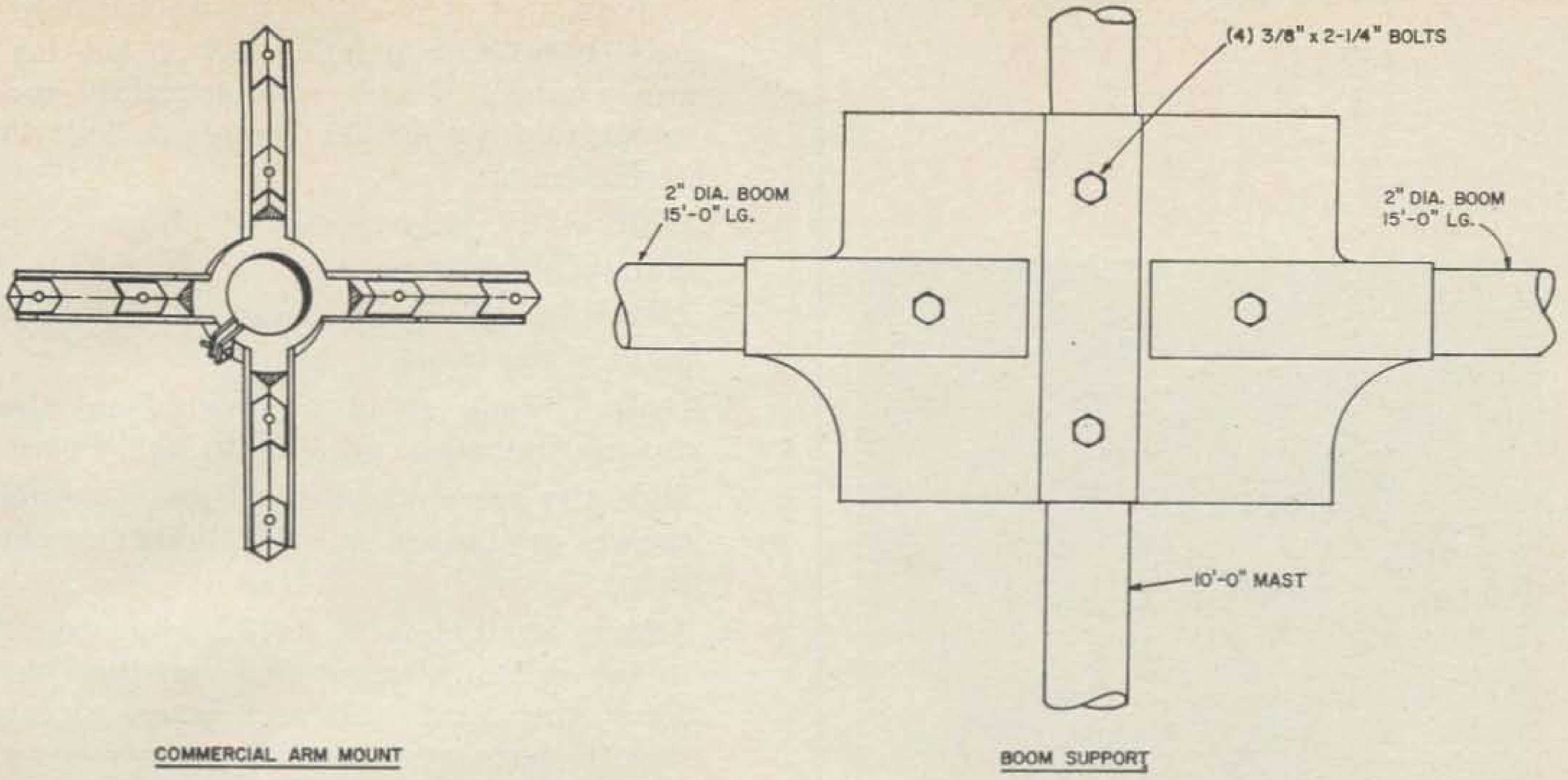
The clamp must be capable of supporting both the 2" boom and the 1½" mast above and below the boom (Fig. 2).

About 50' of ¼" galvanized guy wire, 2 heavy duty turnbuckles and 8 cable clamps are needed to give the boom additional support (Fig. 1).

Several companies offer all of these parts for under $150 including the boom. This price can be cut if one makes any of the parts himself or has them on hand from other antenna projects.

There is no real difference between a quad shaped like a diamond and one shaped like a square. The important thing is the feedpoint (Fig. 1). Feeding the antenna at any point marked H results in horizontal polarization and feeding at any point marked V will result in vertical polarization.

The most widely used polarization is horizontal. It is easier to tune the antenna and the tower will have less effect on the antenna than if vertical polarization would have been used.



COMMERCIAL ARM MOUNT

BOOM SUPPORT

Fig. 2. The commercial arm mount and boom support used with the four element 20 meter quad. This particular design has withstood winds up to 80 miles per hour.

The diamond quad offers an excellent route for the feedline to be run. The feedline can be taped directly to the fiberglass arm with no ill effects. The square quad requires 4 insulators, one for each element (Fig. 1).

A quad is not an especially broad-banded antenna; the SWR can be tuned to almost 1 to 1 at any one frequency but the SWR rises more rapidly than does the SWR in many beams. This is not a serious drawback as the SWR is under 2 to 1 over most of the band (Fig. 3).

The resonant frequency can be changed easily by lengthening or shortening the wire or by using coils, shorted stubs, tuning stubs or other tuning methods.

The length of the wire on each side of the quad can be calculated by using the formula 248 or the formula 984 for the total length of each loop. The approximate total length of the wire for the 20 meter phone band is:

1st director	66′ 6″
2nd director	68′ 3″
driven element	70′ 0″
reflector	71′ 9″

The above lengths were calculated by increasing the driven element length 2½% for the reflector and by decreasing the directors 2½% from the driven element size.

The radiation resistance of the quad will be close to 50 ohms and the greatest gain will be achieved when the elements are spaced:

1st to 2nd director	10′ 6″
director to driven	9′ 3″
driven to reflector	9′ 9″

This uses all but 6″ of the 30′ boom.

1. Select a flat place in the yard to lay out the quad arms. Mount the arms to the arm mount. Do this to each of the 4 mounts.
2. Drill 1⁄16 holes in the arms approximately 12′ 1″ from the center of the boom; drill a 2nd hole at 12′ 3″ in the bottom arm of the driven element. Be sure to drill all holes straight and in a level plane.

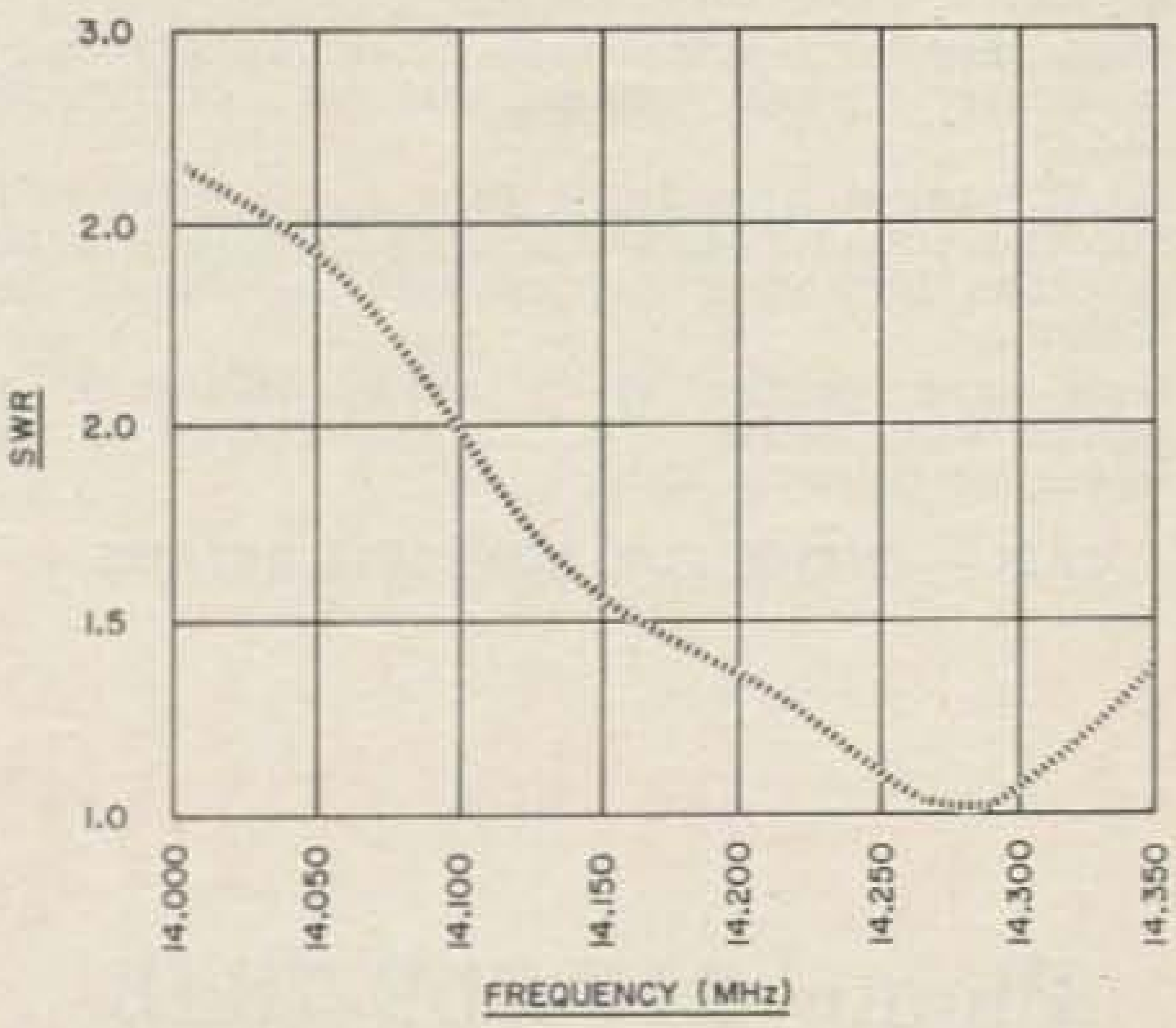


Fig. 3. Standing wave ratio of the four element quad. Although this unit was tuned for minimum SWR in the phone section of the band, even at the low end the SWR barely exceeds 2.5:1.

3. Thread the wire, #14 enameled copper, through each hole, and on the last arm connect the 2 ends together and solder forming a closed loop; do this to each element.
4. Drill a ¼" hole about 1" from each end of the boom.
5. Attach a 10' x 1½" mast at its midpoint to the boom.
6. Drill ¼" hole about 2' down from the top of the mast parallel to the boom.
7. Slide the elements on the boom (a little grease or butter on the boom might help).
8. Attach feedline (52 or 72 ohm coax) to the driven element and run the coax along the quad arm and boom taping it with permanent black tape as you go.
9. Push 5' of the ¼" cable through the holes in the mast and attach the turnbuckles to each end of this wire. Cut the rest of the steel cable evenly and attach the wire to each end of the boom and to the other end of the turnbuckles (Fig. 1). Be sure that the turnbuckles are as wide as they will go before attaching the cable.
10. Raise the antenna to the top of the tower and drop it into place.
11. Tighten rotator bolts.
12. Tighten turnbuckles so that the boom is straight.
13. Run the feedline through the inside of the tower. Drive a 8' ground rod into the ground as near as possible to the base of the tower. Connect the outside braid of the feedline to the ground.

This quad has survived winds of 80 mph on a self-supporting tower 50' above the ground. If additional strength is desired a piece of wood or similar substance can be run through the boom to give additional horizontal support.

The gain of the antenna varies according to what method of measurement is used. Comparing this antenna's gain to what manufacturers claim their antennas get, this antenna exhibits a gain of about 12 dB. This gain was measured by using a S-meter in a communications receiver using a dipole 10 wavelengths away from the antenna.

This is more than enough gain to work most stateside and DX stations using either high or low power.

. . . K0UKN

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Tilt that Quad at A Dollar A Foot

When the quad bug hit me three years ago, a basic fact of antenna design came into sharp focus. The delta-quad configuration I planned was comparatively new, and I had no doubt that there would be a long period of pruning and tuning. This called for a simple method of raising and lowering the antenna. Even if my calculations were accurate, I knew the antenna would have to go up and down dozens of times so that it could be adjusted for this particular location in order to correct for the individual conditions such as our unusually poor ground, the proximity of the carport, power lines, etc.

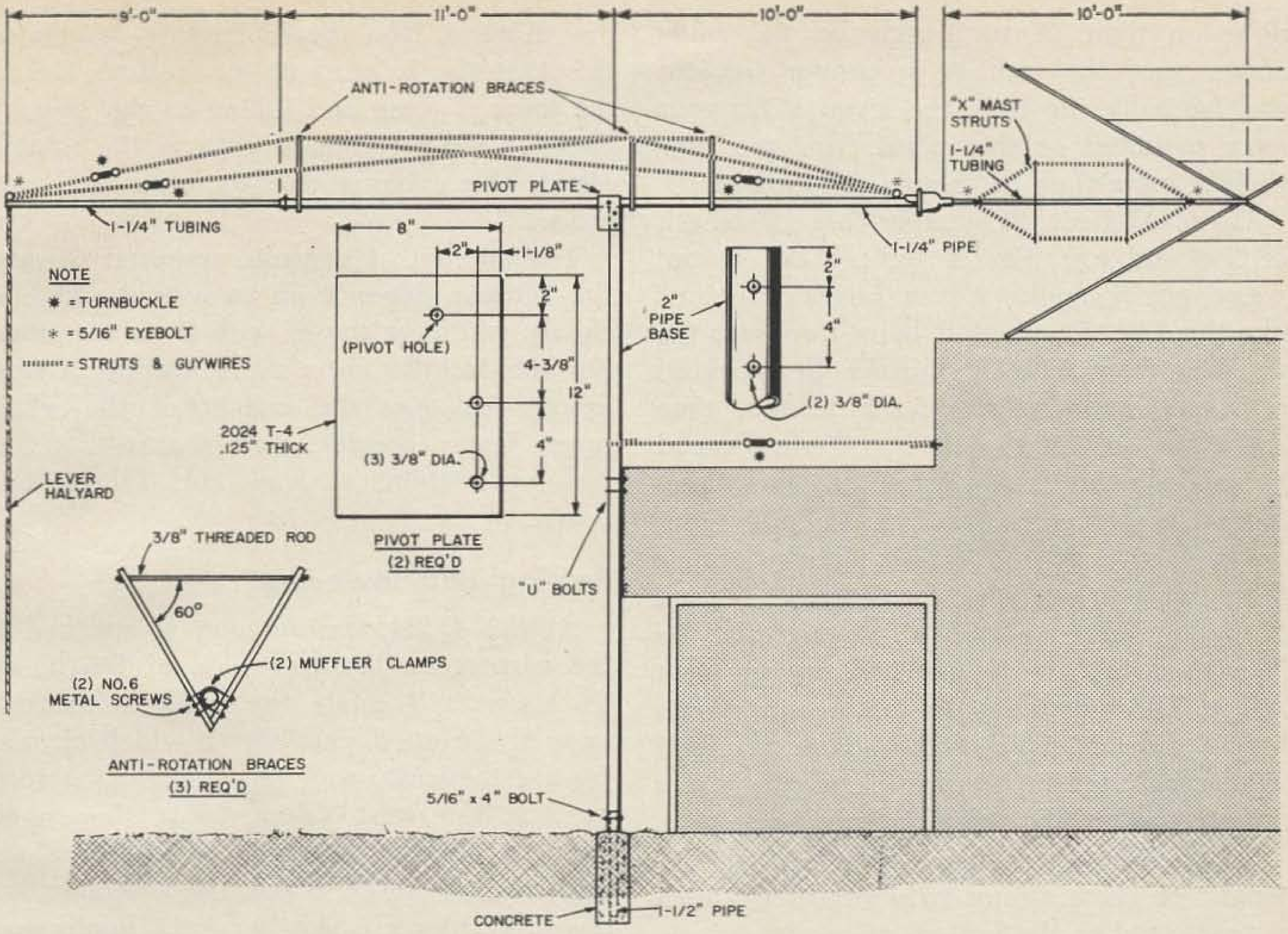
So before the antenna itself was touched, I concentrated on a "tower"—a somewhat generous term—that would permit quick, easy adjustment. Consideration was given to several of the sturdier crank-ups, tilt-overs. Had I been able to afford one of the more de-luxe commercial models, particularly those with power driven winches, there would have been no problem except that of adjusting, cutting, trying and re-adjusting at the 20′ level. The cost of this equipment, however, went far beyond my classification or hobby expense, so I gave the question considerable thought and came up with the gadgetry shown in **Fig. 1.** It is ultra-simple, delightfully inexpensive, and completely effective for lightweight antennas.

Basically, the tower consists of two parts: a solidly set fulcrum at a reasonable height, a lightweight lever arm that would be able to take punishment. The whole works had to be high enough to raise the spider of the quad to a 41′ height (half-wave on 20 M. for the bottom part of the quad square); had to be able to live with summer windstorms with gust velocities of at least 65 MPH.; and had to make the raising-lowering procedure a matter of minimum effort and time. I felt that it could be done at a low cost. It can.

There are two basic elements:

The fulcrum

A height of 21′ seemed like a good fulcrum point for two reasons. First, it would allow the antenna to be lowered to the roof of the house at an angle that would allow me to make adjustments easily. Secondly, standard 2″ black or galvanized pipe comes in such lengths, and with somewhat limited tools, I wanted to keep work to a minimum. I was fortunate in being able to buy from a local surplus metals dealer a piece of lightweight black pipe which has the same outside diameter (2.375″), but has a lighter wall (.121″ vs. .154″). It is lighter in weight, easier to handle and drill, and is cheaper in price. To use this pipe as the fulcrum requires the drilling of two parallel ½″ holes at one end, 2″ down from the end and 4″ apart. (See Fig. 2). An anti-rotation bolt is added later. The fulcrum materials include, in addition to the pipe, two pieces of ⅛th inch aluminum, 8″ x 12″ of a hard alloy such as 2024 T4 or harder. They are drilled with holes to match those on the pipe as shown. The additional ½″ hole higher and to the left of the mounting holes, is the actual pivot point. Machine bolts, ½″ x 4″, hard-drawn and with lock washers are used to secure the two plates to the pipe. Mounting to the side of the house or carport is a matter of material available, personal choice, etc. A simple method is shown in **Fig. 1.** A 4′ length of 1½″ pipe was set in a chunk of concrete roughly 1′ x 3′ x 3′ deep, with about a foot of the short pipe above ground, slightly offset from the facia boards of the carport. The base fulcrum is erected in as vertical position as possible by slipping the lower end over the stub in the concrete and tying the upper portion to the house facia in the most convenient and sturdy manner. Drill a 5/16″ hole through both pieces of pipe and use a 5/16″ x 4″ hard-draw machine bolt to keep the 2″ pipe from trying to rotate. Here I used two "U" bolts securely anchored



to the facia, plus a guy wire tightened with a turnbuckle to another facia board. For the base section, that's it!

The lever

The basic component of the lever is a 21' length of 1¼" black pipe with a ½" hole drilled at a point 11' from one end for the pivot bolt. At right angles to this hole, two 5/16" holes are drilled, one 1" from the end of the 11' side, the second 7" from the 10' side. These are for the eye bolt used for the bracing cables, and the bolt used to attach the extension arm.

The last major piece of material is a 21' length of steel tubing with an OD of 1¼". I buy these in Phoenix from wire fence contractors for about $3.25 per length. This tubing is amazingly resilient, and has been used for dozens of tough antenna chores. Cut off ten feet of this length, and set it aside for the top section of the whole works. The lower section is drilled at one end with a 5/16th" hole to match the anchor bolt, and with another 5/16th" hole about a foot from the end to match the hole in the 1¼" pipe so that the pipe and tubing can be bolted into one unit.

Examination of the sketch of the lever will show that there is a heavy strain on it when it approaches the horizontal position. A pair of braces attached to the arm itself transfers this load to a 3/16th" bracing cable. I use two pieces of scrap aluminum channel, about ½" x ½" x 2'6" at each of the two brace points, secured to the pipe by "U" bolts. Really throw your weight into getting

Material List	Approx. Cost
1 length 2" pipe, black or galvanized 21' Fulcrum Base	$11.00
1 length 1¼" pipe, black or galvanized 21' Lever arm	6.75
1 length 1¼" steel tubing 21' Lever extension and top mast	3.00
2 pcs. aluminum plate, 8" x 12" x .125" 2024 T-4 or similar pivot plates	3.00
1 pc. 1½" galvanized pipe, 4' long	1.25
2 pcs. aluminum channel, 3' long, ½ x ½ x .125 or similar for lever arm strut braces	1.80
4 pcs. aluminum channel, as above 4' long for cross-bracing top mast—if top mast cross-bracing is used	4.80
25' ⅛" flexible cable for lever strut, 15' additional if second facia tie is used	.75
Cable clamps, "U" bolts, eyes as needed for your own variations, plus turnbuckles	5.00
60' ¼" nylon cord if top mast cross bracing is used	1.80
20' ¼" nylon cord, or equiv., for lever halyard	.60
	$39.75

The above materials can be purchased at better than these prices in Phoenix from concerns dealing in surplus metals. And even at these prices, with a generous $5.00 for miscellaneous small parts, you are over 40' at less than a dollar a foot . . . What is more important, you can really tune that antenna.

these on tight. A turnbuckle on the cable makes sure the arm is in proper tension, and basically, we have the lever. With your rotor mounted at this point, you are now slightly more than 31′ above the ground.

Up to 41 Feet. Remember that 10′ length of 1¼″ tubing? For a light UHF beam, we've got it made. For a heavier antenna like the DeltaQuad used here, however, the weight (about 25 lbs.) plus the greater wind resistance made me spend a little more time and effort on that top 10′ . . . I cross-braced twice along the length, using the same aluminum channel with two feet extending out on each side of the crosses formed. Since these were inside the quad itself, I used ¼″ nylon cord instead of steel cable. Its "stretch-shrink" cycle has had no apparent effect. The antenna bolts to the top of this braced mast. Center of the spider, 41 feet! The usual egg insulator-broken guy wires are attached to the AR-22 rotator here.

The only other item consists of a 20′ length of cord, strong wire or cable which is connected to the bottom of the lever arm. When the antenna is lowered, this halyard hangs down to the ground and is pulled until you can grasp the bottom of the lever itself.

Assembly

Erect the fulcrum post as shown making sure that it is vertical. Raise the lever arm, complete except for antenna, to the roof. It may take a little help to thread the lever arm into the pivot slot, but I do the job myself with an inexpensive block-and-tackle on the top of a very makeshift gin-pole. It takes a ladder to get to the pivot point, and without the gin-pole, getting the ⅜″ x 4″ pivot bolt can be something of a chore, but with a little push-pull help from a man on the roof, the job can be accomplished in a few minutes. You should be sure as you do this that the halyard at the bottom end of the lever is loose and falling to the ground. Attach your preliminary guys to the rotator, attach the antenna and its coax, and you are set.

The amount of pressure required to raise the antenna depends on its weight and how closely you have stayed with these materials. For this installation, a 23 lb. bucket of sand exactly balances the weight of the whole upper lever complex: next chance I get to pick up a chunk of lead, etc., I'll cut that down.

Raising and lowering

At this QTH, the antenna is attached to the carport on the west side of the house. To lower it, I rotate the quad to the east or to the west, depending on which element I want to work on. I then detach the rotor guy on the west side, release the simple lock that holds the lever to the fulcrum arm and raise the lever so that the antenna starts down. The lever is slowly raised, finally goes to the point that the lever cord is used for the final distance as the antenna comes down to the roof. Outside of antenna rotation, total elapsed time, 10 seconds. After completing the adjustment, the lever cord is pulled and the process reversed. Maybe 15 seconds. Energy expenditure,—little.

On the basis of material costs in Phoenix, we are talking about a total figure for the entire gadget, less guys of about $40.00. The "Tower" has been up for over two years in various sizes and variations. It has taken a lot of punishment from the wind. And most important, it has enabled me to have the antenna easily available for every possible change with the greatest of ease. I think it is a first class investment.

. . . W7UXX

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An Easy-to-Erect Quad

If you want the best antenna for DX, and the one which is easiest for the home constructor to erect; then the antenna for you is the cubical quad.

Now, the first statement is easily confirmed. It is only necessary to sit on the fence and hear what all of the big (and usually rare), DX stations use. I find personally that at least 60% of all European stations use quad antennas.

The second statement is usually not so easily proven. If you have ever struggled up a tower with a twenty-meter beam on your shoulder, or almost slipped a disc when your cubical quad got caught in the stay wires at the thirty-foot level, then I am sure that you agree. There is one way out here, and that is to erect the antenna in two parts, the driven elements and boom in one part, and the reflector assembly comprising the rest.

Fig. 1 shows the boom and driven element section before erection. Ready-made quad parts are not easily available in this country, so we had to start from scratch. We made the boom from 2"OD galvanized water pipe. A ⅛" mild steel plate 6" square is welded to each end of this pipe. One plate has four ¼" holes drilled as shown in the photo, the other end plate has four radial supports welded in place at an angle of approximately 20 degrees to the plate. The third plate has four ¼" holes drilled in exactly the same positions as in the first

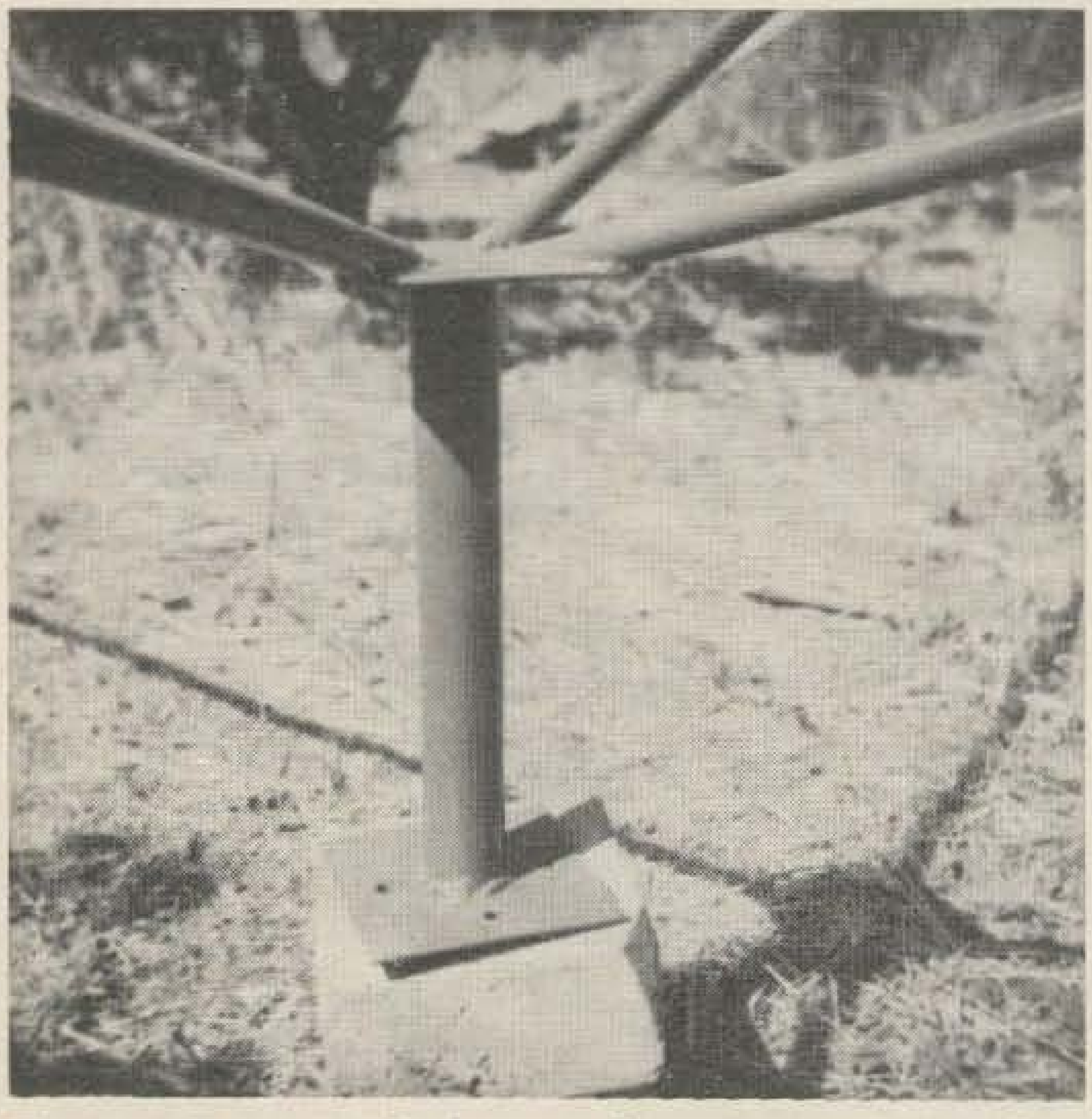
Fig. 1. Boom and driven element section before erection.


Fig. 2. VK5DS holding the driven element section of the quad.

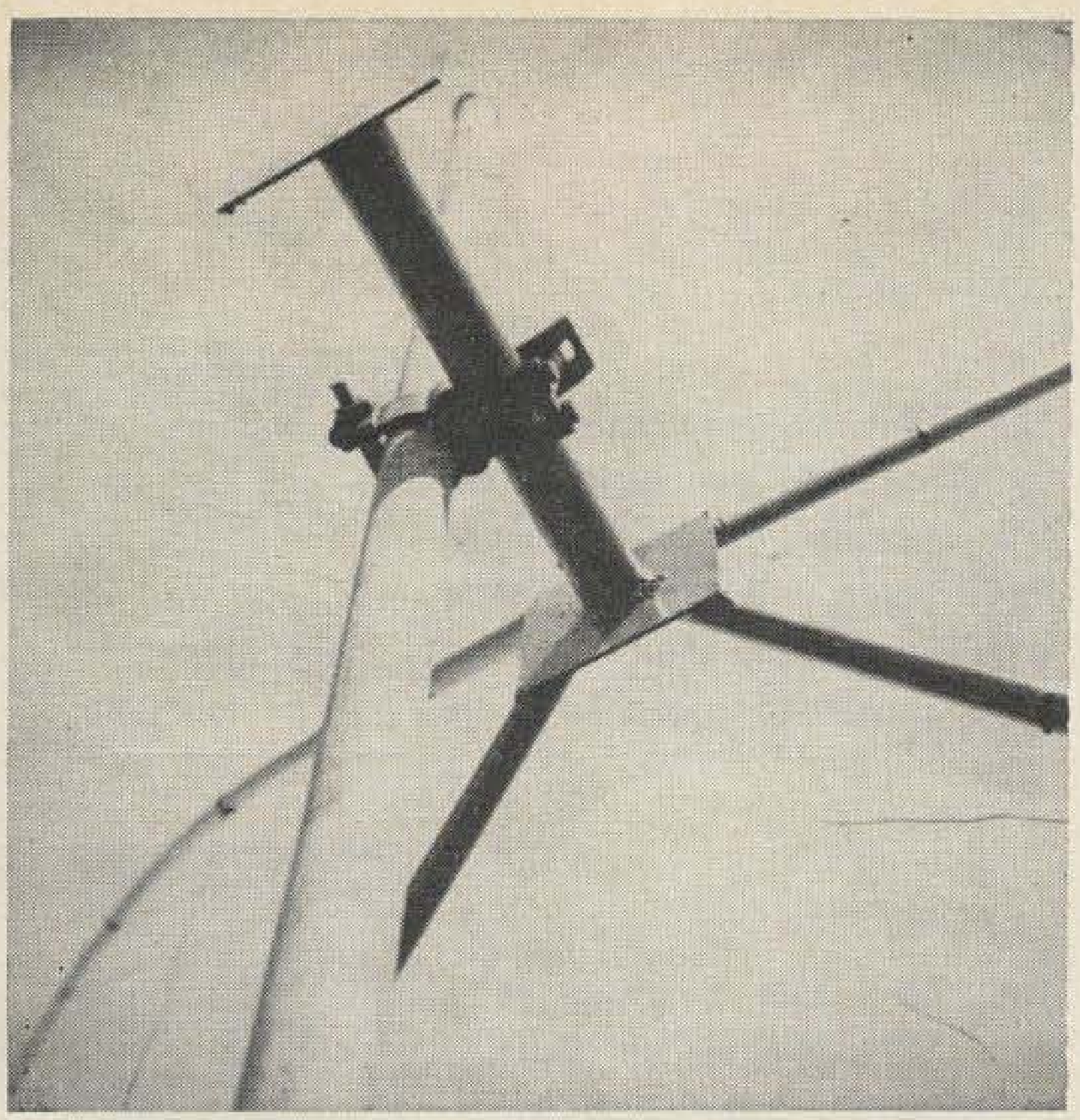

Fig. 3. The boom is attached to the mast with a builder's scaffold clip.

plate as well as the other four radial supports, which are welded, also at 20 degrees.

These eight radial supports are made from galvanized 1″ OD steel tubing, each being two feet long. The radials themselves can be made of anything. We used Australian oak, (a long-grained timber), and finished them with marine paint. Fiberglas fishing rods would be better, if available. Whatever material is chosen, the radials need to be about 13′ long.

Element lengths can be found in Bill Orr's *Quad Antenna Book,* and it is strongly suggested that the wires be laid out on the ground and individual lengths marked off so that they remain symmetrical when wound onto the radials.

Erection, as mentioned earlier, is very simple. It is quite easy to handle the individual parts of the antenna, as VK5DS demonstrates with the driven elements in the accompanying photograph. (*Fig.* 2)

The tower at VK5VB is a 60′ Homelite; we climbed to the top and hauled the driven elements up on the end of a piece of rope, which was tied around the boom. The boom was attached to the rotator (2″OD pipe), with a builder's scaffold clip (*Fig.* 3). We have found these fittings a most convenient way out of the problem of fastening which everyone seems to have with antennas which are too heavy to use TV fastenings.

The other elements are then hauled up the tower and fastened to the boom-plate with four ¼″ bolts. (*Fig.* 4)

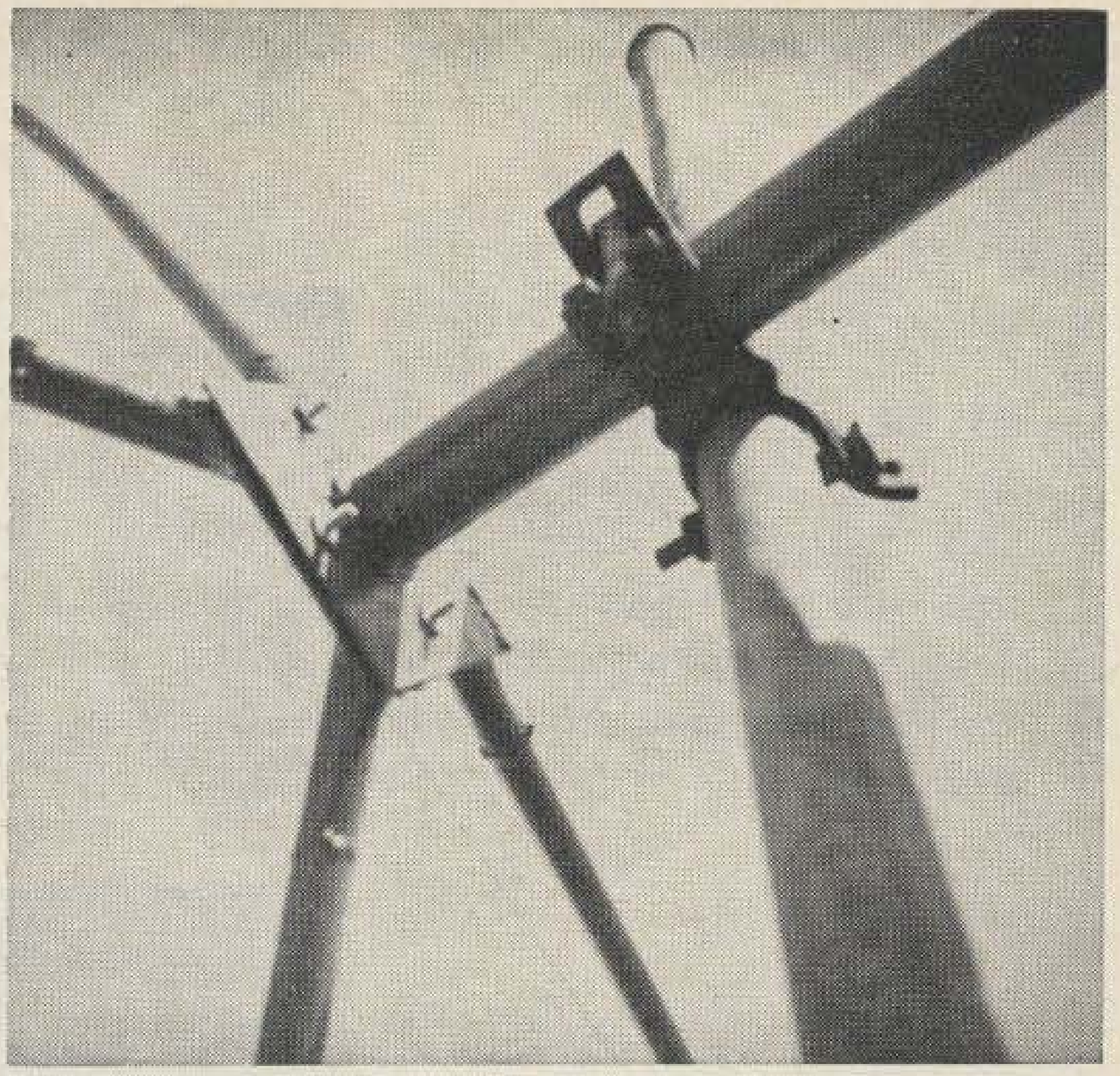

Fig. 4. The other elements of the quad are raised with a rope and fastened to the steel plate on the opposite end of the boom from the driven elements.

If a crank-up tower is used it becomes that much simpler to mount the thing. You can then climb up a stepladder with the antenna sections one at a time and it becomes a one man operation.

We drive each section of the antenna separately with 72 ohm coax and the radiation resistance is correct on all bands up to 50 MHz. This of course is largely because the correct ratio of reflector/driven element spacing has been maintained on all bands.

The finished job, whilst not aesthetically appealing to my wife, I think looks pretty good (*Fig.* 5).

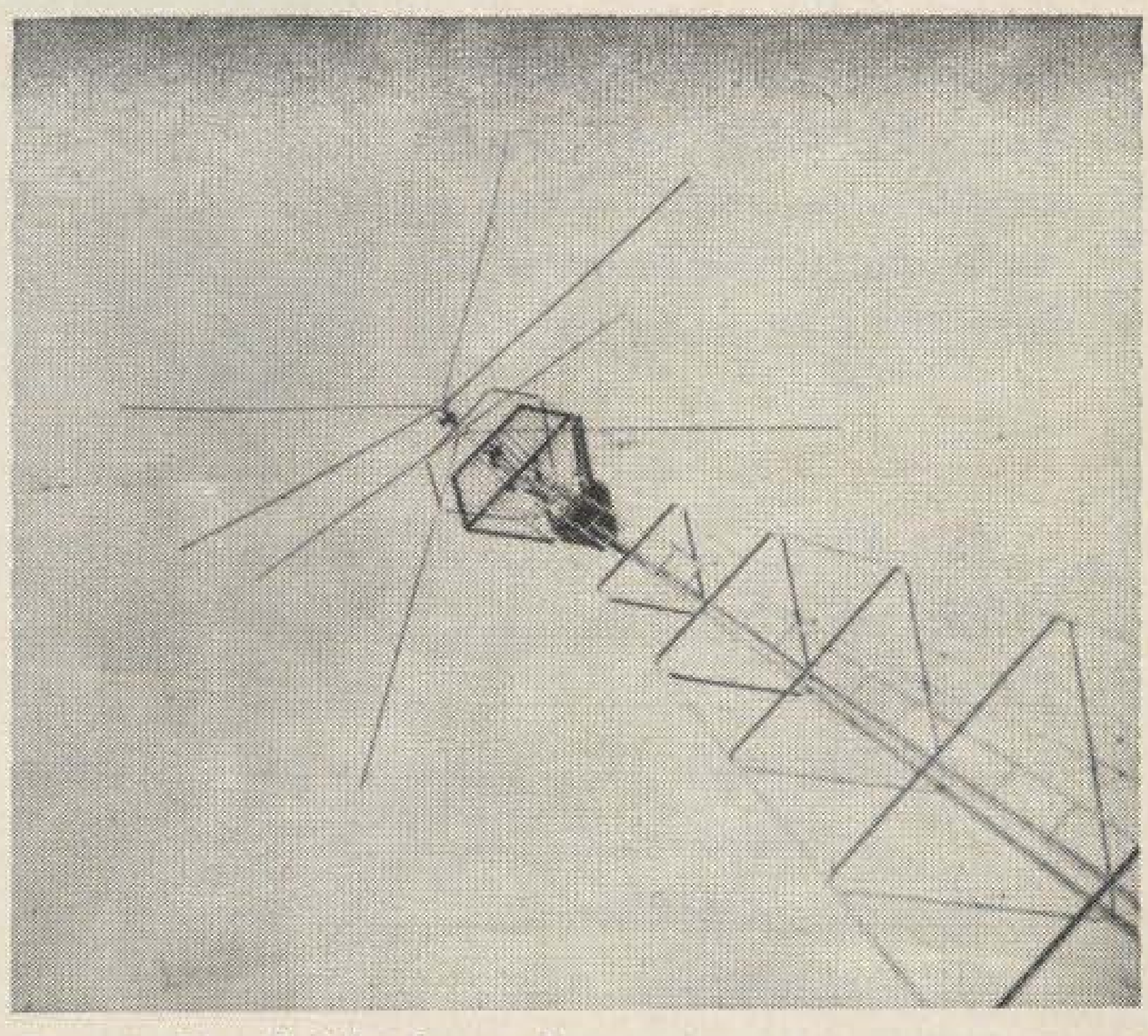

Fig. 5. The finished quad.

. . . VK5BI, VK5VB

Bibliography of the Cubical Quad

Since the first published description of the cubical quad by W1DF in QST for November 1948, there has been a veritable flood of quad articles published in the amateur magazines. W1DF noted in his article that the quad *apparently* originated at HCJB in Ecuador; from this rather obscure beginning the quad has grown into one of the most popular amateur antennas. There are two element quads, three element quads, four element quads, quad kits and quad packages—with sizes and prices to fit nearly anyone's space and pocket book. The following is a comprehensive list of cubical quad articles that have appeared in the ham magazines since W1DF's original description back in 1948.

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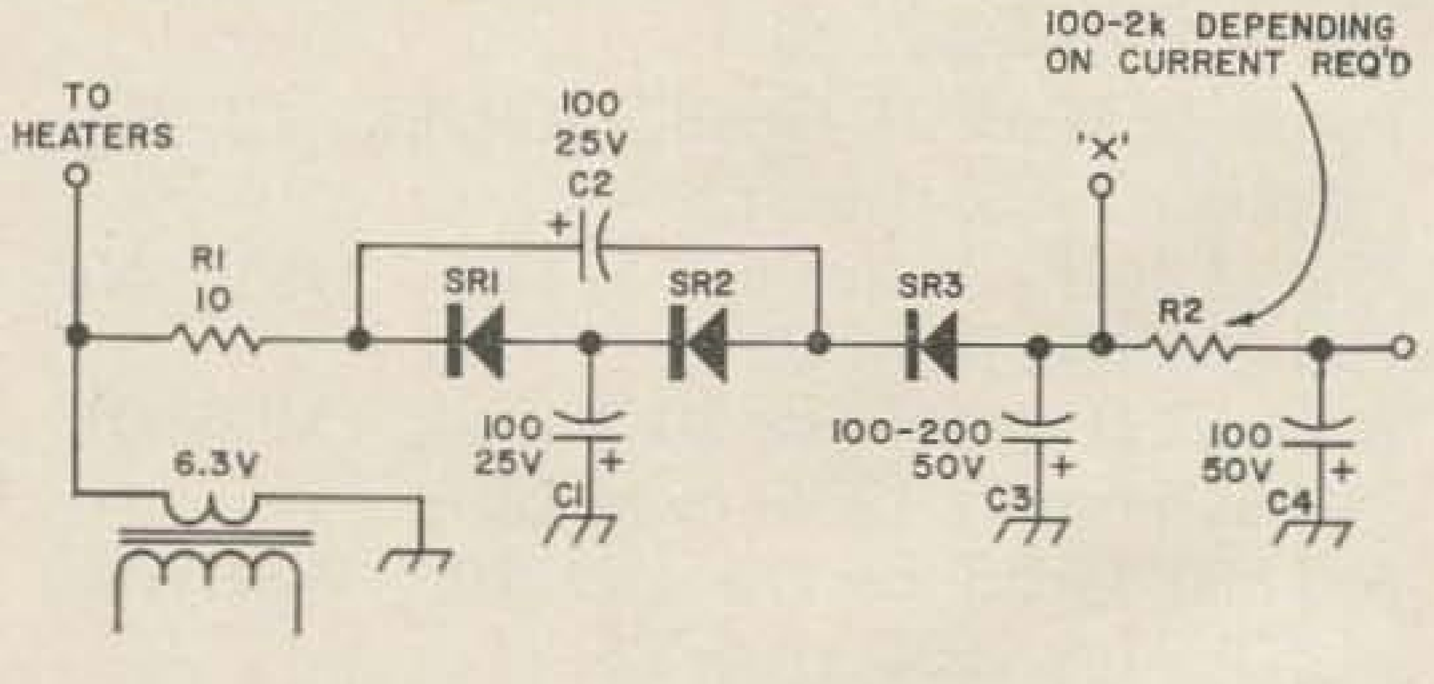
. . . Jim Fisk, W1DTY

Simple Bias Supply

Possibly the reason that many amateurs do not use protective bias in their transmitters is that bias supplies are usually expensive and hard to locate. There are very few transformers that are suitable for bias supply use on the surplus market and new ones are costly. A very simple supply can be made from the heater supply of the transmitter. The circuit shown is a half-wave tripler operating from the 6.3 volt heater line. SR1, SR2, and SR3 are low voltage silicon rectifiers. Usually the filtering is adequate at point X. If more filtering is desired, R2 and C4 can be added. The output should be between 20 and 30 volts. If a higher voltage is desired, taking the ac off a 10 or 12 volt winding, if one is available, will raise the voltage to approximately 50 volts. Other uses for this supply include: bias for linears, bias for class AB1 and AB2 modulators, power for transistorized stages, etc. The supply can be used to deliver quite a bit of current, probably a few hundred milliamperes. It has good regulation and can be used for bias in stages where grid current is drawn, such as class B modulators, etc. The total cost for the supply should not exceed $3 or $4, and can be built for considerably less if some of the parts are in the junkbox.



. . . Larry Levy WA2INM