A Cubical Quad for 20 Meters

Reviving a Neglected Type of Beam

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• The cubical quad enjoyed brief popularity when "10" was in its glory, but has practically disappeared along with sunspots and ten-meter activity. The author finds it highly satisfactory on 14 Mc. and offers reasons why it is worth serious consideration if you're thinking of putting up a beam.

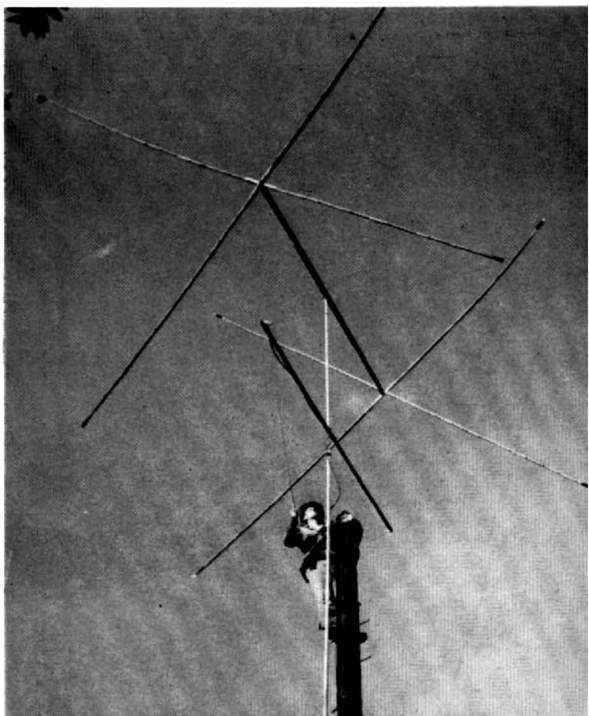
In pursuit of our hobby we occasionally run across a piece of equipment that performs in a satisfactory manner, is easy to build, simple to adjust and low in cost, yet for some unknown reason is neglected and forgotten by the majority of amateurs. Such is the case of the cubical quad antenna. A few years ago, when 10 meters was open, the quad enjoyed considerable popularity. Many amateurs reported that it gave them results equal to, and in many cases superior to, the conventional 3-element Yagi, some claiming gains as high as 10 to 11 db.[1, 2] Measurements at ARRL headquarters gave the quad a gain of 7 to 8 db. over a reference dipole antenna, a gain equal to that of a good three-element beam.[3]

As 10 meters faded out so did the quad; the fellows who had been so enthusiastic about it failed to carry through and use it on the lower frequencies. Comments received over the air now indicate that many hams do not know what the quad is or what it is capable of doing. Those who are familiar with it seem surprised that a practical one for 20 meters could be built and all assume it would be a monstrous affair. Actually, the quad occupies less space and appears smaller than a three-element beam.

The cubical quad consists of a radiating element and a parasitic reflector, usually spaced 0.15 or 0.20 wavelength, both radiator and reflector consisting of square loops one quarter wavelength on a side, making a total of one wavelength around the loop. This configuration can be arranged either as shown in Fig. 1A or Fig. 1B, that shown at 1B giving slightly higher gain.[3] In some installations the reflector is made a little longer than the radiator as in Yagi beam construction, in others it is made the same length as the radiator. In either case, provision is made for tuning the reflector by means of a shorted stub or variable condenser in order to obtain optimum phasing. These square loops may be thought of as two half-wave elements stacked one quarter wavelength apart with their ends bent to connect them together, hence a lower angle of radiation is obtained than would be expected from a simple two-element beam. Many of the early versions used two-turn loops for radiator and reflector but this served no purpose except to raise the feed-point impedance.[3]

Performance Data

The amateur literature has very little to say regarding the mode of action of the quad and anyone interested is urged to read the articles mentioned above. Since this antenna seemed to have several advantages over the Yagi and as very little experimental work had been reported on it, a scale model for the 50-Mc. band was built to try to determine some of its characteristics. All measurements were made with the center of the array one wavelength above ground and the instruments used were a Heathkit AM-1 antenna impedance meter, a Millen grid-dip oscillator and a homemade field-strength meter. The test signal was furnished by a transmitter feeding into a dipole elevated one wavelength above the ground and located three wavelengths from the antenna being tested. All measurements were



W5DQV adjusting the phasing stub on his 20-meter quad. The main supports are bamboo fishing poles.

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[1] The *CQ* Staff, "Cubical Quad, Topic Number One," *CQ*, December, 1948, p. 37.

[2] Hoffman & Middelton, "Constructing the Cubical Quad," *CQ*, June, 1949, p. 11.

[3] "The Quad Antenna," *QST*, November, 1948, p. 40.

double-checked on two different occasions to make them as accurate as the instruments would permit.[4] The results are tabulated below:

Radiator alone	Imp.	110 ohms
	Gain over dipole	2 db.
Reflector spaced 0.20	Imp. of radiator	75 ohms
	Gain over dipole	10 db.
Reflector spaced 0.15	Imp. of radiator	65 ohms
	Gain over dipole	8 db.
Reflector spaced 0.10	Imp. of radiator	45 ohms
	Gain over dipole	8 db.
Director spaced 0.20	Imp. of radiator	50 ohms
	Gain over dipole	5 db.

The gain figures seem high but they are the actual readings obtained. The radiating element alone, without reflector or director, gave a consistent gain of 2 db. over a well-matched and trimmed dipole. This does not agree with the published figures for a square loop; nevertheless, this 2-db. gain was obtained on two different occasions, using different loops and different dipoles, all grid-dipped to the correct length. Disregarding this 2-db. gain of the square loop, the 0.20 spaced quad still gives a gain of 8 db., a very respectable gain indeed.

A field pattern taken with the reflector at 0.15 is shown in Fig. 2. A pattern taken at 0.20 showed a similar outline but with somewhat greater attenuation of the back lobe.

The radiation from the sides of these test beams and the one used on 20 meters was remarkably low, the field-strength meter indicating almost zero off the sides. On-the-air tests with the 20-meter quad showed a 45-db. front-to-side ratio and 25-db. front-to-back ratio. A square element tuned as a director and spaced 0.20 wavelength gave a gain of 5 db. over the dipole, which brings up the interesting possibility of a three-element quad using 0.15 or 0.20 spacing for both director and reflector. Such a beam might prove considerably better than a three- or four-element Yagi. Time limitations prevented investigating these possibilities, but it is hoped that the above experimental work will stimulate more work on the quad by other amateurs. This beam is worth much more attention than it has received in the past.

The 20-meter quad here at W5DQV has created considerable interest, nearly half the stations contacted asking for more information about its operation and construction. After fourteen months' operation on 20 c.w., this antenna has proven its worth as it has given results equal to and often superior to the three-element wide-spaced beam it replaced. It is definitely smaller than the usual three-element beam, having a "wing span" of only 16 feet 9 inches as compared to 33 feet, a boom length of only 12 feet as compared to 20 or 24 feet, and as described here, a weight of about 20 pounds. Yet this is a full-sized beam capable of giving full-sized performance; there are no shortened elements and there are no loading coils to absorb power. It is easily turned by a TV rotator, is constructed of readily obtained materials, and can be built, put in place and tuned in one or two week ends.

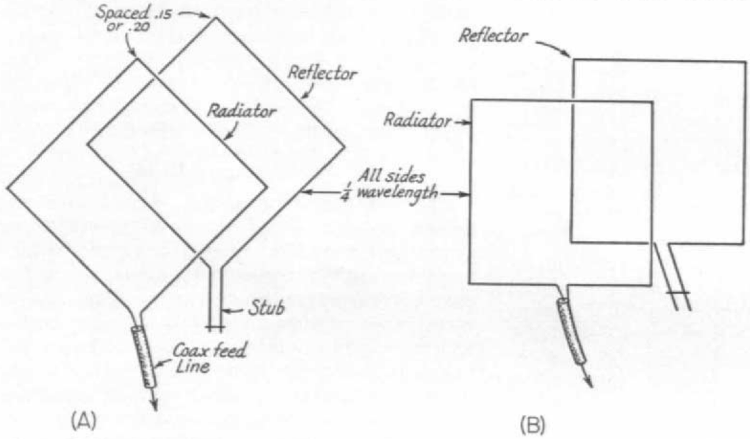

Fig. 1 — Two different arrangements of cubical quad antennas.

Construction

Most of the details of construction can be seen in the photo and drawings. It was built to be as light as possible and while it does whip some in the wind, this does not seem to cause any notice-

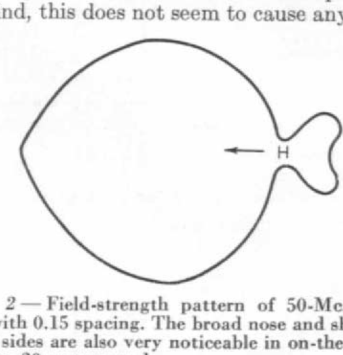

Fig. 2 — Field-strength pattern of 50-Mc. cubical quad with 0.15 spacing. The broad nose and sharp dips off the sides are also very noticeable in on-the-air tests with the 20-meter quad.

[4] Antenna measurements of any type tend to be tricky, even with elaborate and accurately-calibrated equipment, because of the difficulty of detecting and eliminating stray effects which sometimes are of the same order of magnitude as the quantities under investigation. Results such as those tabulated here (and other similar tabulations of antenna performance figures) are of considerable value, practically, if it is kept in mind that they are necessarily approximations, useful as a guide but not to be taken as literally as, say, the reading of a good quality d.c. voltmeter. — Ed.

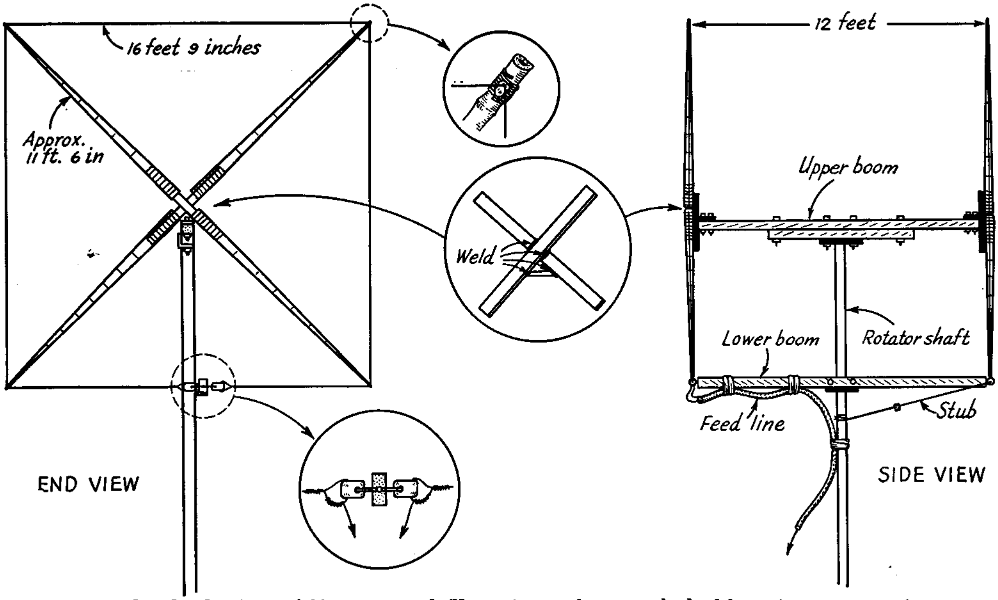

Fig. 3 — End and side views of 20-meter quad. Upper insert shows method of fastening antenna wire to support arms. Center insert shows construction of support-arm mounting bracket. Lower insert shows method of attaching feed line and stub to the center insulators. Two small egg insulators are used, fastened to end of lower boom as shown with a small nail.

able change in loading or on received signals. There is nothing critical in the construction except the length of the wire elements, and no doubt many will devise better ways to build and support this antenna. One of the quads built by a local ham used 1 × 2-inch pine for the support arms but this beam was much too heavy and blew down in the first light wind. The support arms shown in the drawing are ordinary bamboo fishing poles about 16 feet long, with the butt ends wrapped with friction tape to prevent the metal mounting bracket and wire from biting into the bamboo. These arms are fastened to the mounting brackets as shown in Fig. 3 with several turns of No. 14 galvanized wire, and the far ends are not trimmed until the antenna wire has been fastened in place. Two mounting brackets and eight bamboo support arms are required. The mounting brackets serve to hold the arms in place and to fasten them to the end of the boom. These brackets are made by welding two 24-inch lengths of 1-inch angle iron together back to back to form a large "X" 90 degrees between legs, and welding a 5-inch length of 1½-inch strap iron between two of the legs to fasten the "X" to the boom end. The arms are assembled and the antenna wire is fastened in place before attaching the brackets to the boom.

Many amateurs will raise their eyebrows at the idea of using fishing poles in construction of an antenna, but if the poles are well treated with a weatherproofing compound they will last several years. Weatherproofing compounds are available at all lumber dealers. This antenna has been up for over a year in all sorts of weather and as yet shows no signs of wear. Be sure to get straight poles with no splits in them. No insulators are necessary, the poles themselves acting as long insulators. The antenna shown in the photo uses plastic insulators but subsequent beams have shown these to be unnecessary. The easiest way to mount the antenna wire on the arms is to lay a long length of wire on the ground and mark it at quarter-wave intervals, in this case 16 feet 9 inches, and use these marks to indicate where the wire fastens to the pole. Fasten loosely at first as it will be necessary to slide these joints up and down the poles a little until all four sides of the

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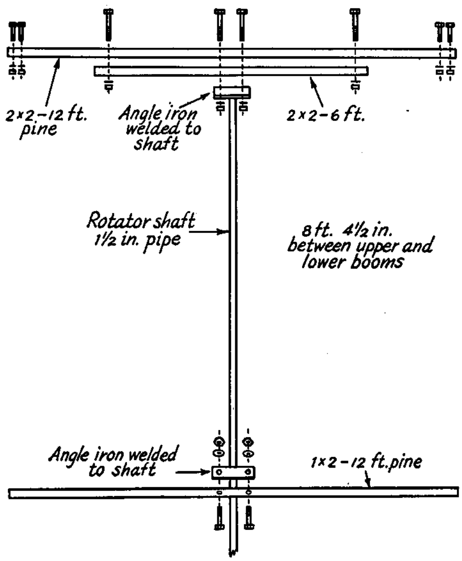

Fig. 4 — Assembly of booms and rotator shaft. All bolts are ¼ inch.

Cubical Quad

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loop are at equal distances from the center. A permanent joint can then be made between antenna wire and pole by wrapping several turns of bare copper wire tightly around the pole where the antenna touches it, threading the ends of this bare wire through small holes drilled in the bamboo pole, and then soldering together as shown in Fig. 3. Use a good grade antenna wire so it will not stretch later.

The main boom consists of a 12-foot piece of 2×2 pine with another 6-foot piece used as a center brace to prevent the ends of the boom from dropping. This boom is mounted at its center by bolting it to a piece of angle iron welded to the top of the rotator shaft. A lower boom composed of a 12-foot piece of 1×2 pine is mounted by means of a small bracket 8 feet 4½ inches down the rotator shaft parallel to and in the same plane as the main boom. The completed radiator and reflector are fastened to the ends of the main boom by means of the mounting brackets, and the center insulators for the radiator and reflector are fastened to the ends of the lower boom which also serves to support the feed line and the reflector stub. This lower boom is probably unnecessary but it does make the beam neater and stronger.

The radiator and reflector are made exactly the same. Small insulators are placed in the center of the bottom side of both reflector and radiator and the stub is fastened to the one and the feed line to the other. Seventy-two ohm coax will give a very close match, but 52-ohm coax has been used here with very good results, even though there is some mismatch. The stub for the reflector is 6 feet long and spaced 3 inches. A very simple sliding short can be made by putting a Fahnestock clip on each wire of the stub and then soldering a wire between these clips. This "short" can be easily slid along the stub from the top of the antenna tower or pole by means of a small stick. Remember to use bare cooper wire for the stub or the sliding short will not work. After the beam is in place atop the tower, the reflector may be tuned by sliding the shorting bar up and down the stub until a minimum S-meter reading is obtained from a local ham located off the back of the beam. That is all there is to it; you are now tuned on the nose and ready for business.

Antenna articles always seem to contain a paragraph or two telling about the results achieved with the antenna under consideration, usually in very glowing terms. This article is no exception. This beam has consistently given good results, DX reports averaging about 1 "S" point higher than on the old three-element job, and if the band is open at all it is unusual to call CQ DX and not receive at least one reply. The power usually runs 125 watts here. This beam is not a cure-all for your DX and QRM problems, but it will certainly give the three-element boys a good run for their money. Put one up — you'll like it.