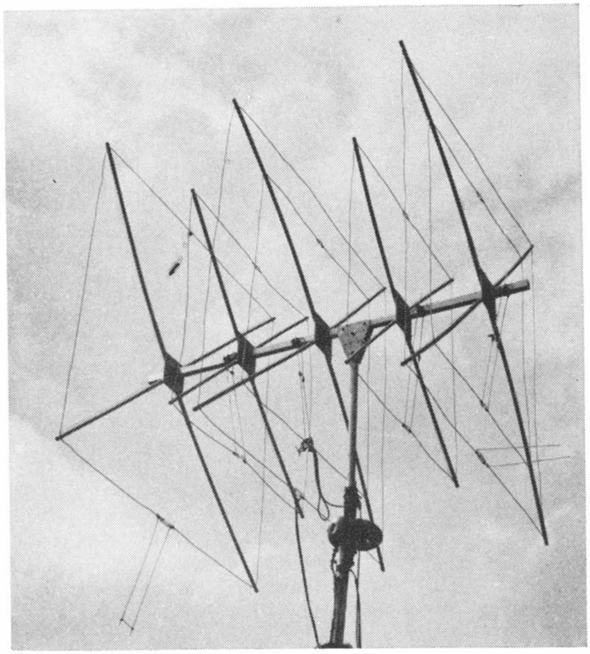

The interlaced quad for 50 and 144 Mc. is a v.h.f. version of multiband quads more often used on 28, 21 and 14 Mc. With the array in this position, the forward lobes of the antenna are toward the right. The array is light enough to be handled by a TV rotator.

An Interlaced Quad Array for 50 and 144 Mc.

V. H. F. Adaptation of a Popular H. F. Beam Design

BY ERNEST H. ADOLPH,* K8WYU

THE quad antenna, in various forms, has long been popular on 10, 15 and 20 meters, but it has been little used in v.h.f. circles. Just why this is so is not entirely clear, though presumably economics has something to do with it. Arrays of the yagi type for lower bands may be fairly expensive to buy or build, whereas the quad lends itself readily to low-cost improvisation. On the v.h.f. bands the cost difference is probably less.

The quad idea seemed to have attractive features for v.h.f. service, particularly where more than one band is involved. Quads would be cumbersome in a stacked system, but if they could be interlaced effectively it appeared that quite good performance would be possible on 50 and 144 Mc., with a structure no larger or more difficult to rotate than stacked yagis of comparable gain. An outstanding feature of the quad, for any band, is the ease with which it can be tuned up for maximum performance, by means of adjustable stubs. The quad also has a lower radiation angle than a single yagi at the same height. These points made an interlaced quad for 6 and 2 meters worth a try, so the project described here was undertaken. The results may be of interest to other v.h.f. men who like to build and tune their own antennas.

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Types of Quads

For those unfamiliar with quad literature, there are two versions in common use. These are shown schematically in Fig. 1, with dimensions for the v.h.f. model. At the left is the type most often employed on lower bands, a continuous loop of wire a quarter wavelength on a side, fed at the low-impedance point at the middle of one side. The other is a half wavelength on a side, broken at the top, and fed at the bottom, at a high-impedance point. This is often called the "X-Q quad."

At first, some thought was given to interlacing two quads of the former type, in order to standardize on feed methods, but mechanical counsiderations and the need for as high gain as possible on 144 Mc. suggested the conventional quad for the 6-meter portion and the X-Q for the 2-meter one. A practical combination worked out to be three elements for 50 Mc. and four for 144. Previous experience with quads and published

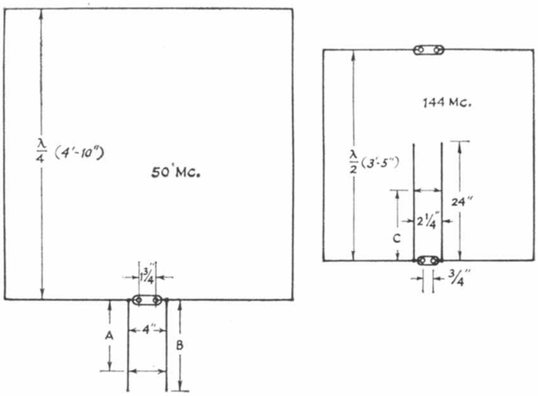
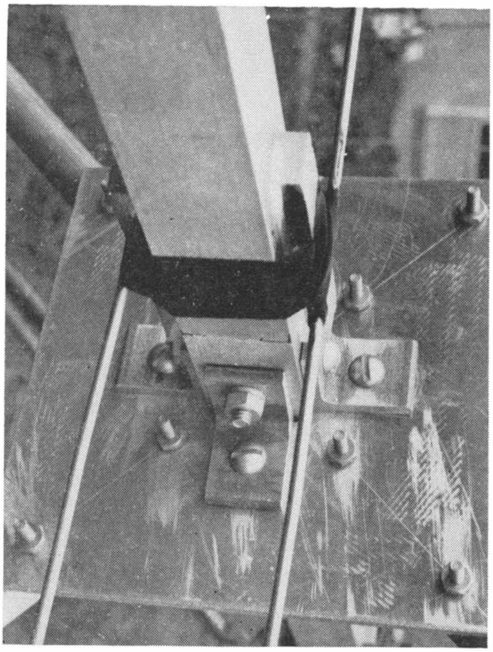


Fig. 1—Details of the interlaced quads for 50 and 144 Mc. The tuning stubs on the 6-meter elements hang free, while those on the 2-meter elements are brought up to the center of the array and taped to the boom, as shown in one of the photographs. Approximate dimensions in inches for the various elements are as follows: Director 1—A not used, stub open, B 13 inches, C 11 inches. Director 2—C 12½ inches. Driven element—A and B not used, C 13¼ inches. Reflector—A 18 inches, B 20 inches, C 18¾ inches. All stub dimensions are approximate. Final position of each short is determined with the antenna installed.

information indicated that substantial gains should be possible on both bands with this configuration. With a good deal of optimism, plus curiosity, we started surveying available materials for such an array.

Construction

The two quads have their driven elements mounted on one crossarm assembly, placing the feed points adjacent to each other. Five crossarm assemblies are needed. Two of these carry 2-meter elements only, and one is used for the 6-meter reflector. This is seen at the left side of the first photograph. The driven elements (center crossarm) and the 6-meter director and 2-meter forward director are mounted on the two other spiders. The 6-meter director is tuned by means of an open stub, trimmed to length, and the reflector by means of a shorted stub. All elements of the 2-meter portion are tuned with long shorted stubs.



Detail view of one of the 144-Mc. stubs, showing insulating blocks and stub taped in place. One of the square plates for the spider assembly is seen directly in back of the stub.

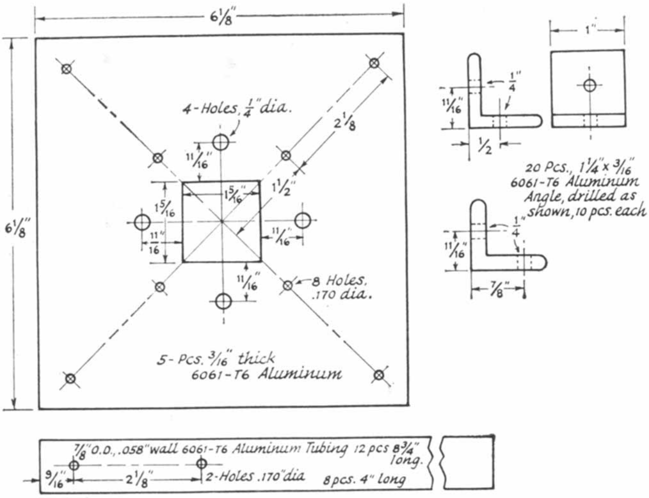
The boom is a 6-foot piece of 1¼-inch square extruded aluminum tubing (6063TS), with 0.125-inch wall thickness. Five spiders spaced 15 inches apart to support the elements are made as shown in Fig. 2. The square aluminum plates are fastened to the boom with four brackets each, cut from 1¼-inch aluminum angle, 3/16-inch thick. It will be noted that these are drilled in two different ways, to permit mounting to the boom with a single ¼-20 bolt and nut per bracket. This bolt goes completely through the boom. A shorter bolt fastens the bracket to the plate. All bolts, nuts and lockwashers are aluminum. The boom is fastened to the vertical support with gusset plates of 3/16-inch sheet aluminum.

Pieces of ⅞-inch o.d. aluminum tubing are bolted radially to the square plates to take the wood-dowel arms which support the wire elements. Dowel stock of ¾-inch round hardwood is available in 3-foot lengths from many hardware stores and nearly all lumber dealers. The pieces of dowel left after making the 29-inch arms for the 2-meter elements are cut 5 inches long and inserted in the mounting ends of the tubes that support the 6-meter elements. The arms of these three assemblies are 41 inches long, so the 5-inch extensions are needed if the dowelling is purchased in 3-foot lengths. The wood should extend the full length of the aluminum mounting tube, in any case, to prevent flattening of the tubes when they are bolted in place. The wood is painted with several coats of Val Oil to provide a water-resistant coating.

Fabrication of the spiders in this way is tedious, and it may well be that a simpler method of building the antenna could be found. However, the construction described results in a rugged array that has stood up well, yet it is light and well-enough balanced so that it can be handled with a TV rotator.

When the spiders are assembled, holes can be drilled in the arms at the proper points to give the antenna dimensions shown in Fig. 1. Dimensions are not particularly critical here, as each parasitic element is made adjustable through its stub. The 50-Mc. stubs hang free. The 144-Mc.

Fig. 2—Details of the metalwork for the spiders used to support the elements of the 2-band quad. The square plate fits over the boom, and is held in place by means of four brackets. Pieces of aluminum tubing, below, placed radially on the plate, serve as sockets for the wood-dowel arms which support the wire elements. Those involving the 6-meter elements are 8¾ inches long, while those for the 2-meter elements are 4 inches.



stubs are brought up to the boom and taped to blocks of polystyrene or plexiglas, which are taped to the boom, as shown in one of the close-up photographs. Another detail picture shows one of the polystyrene insulators and the soldering of the elements and stubs. Once the proper point for the short is found, the sides of the stub can be cut off, or grounded electrically to the boom. This was tried originally, but it was found that locating the proper short position, with the aid of a grid-dip meter, was easier with the ends of the stub insulated from the boom.

The insulators in the latter photo are made in two pieces, and are not assembled around the wires until after the soldering is done. Once the wires have cooled, the insulator can be assembled and the two portions cemented together with epoxy. Clamp them in place until the cement is completely hardened. The joint so made is as strong as the material from which the blocks are cut.

Several different types of solder were tried, but two seemed outstanding: Chemalloy (Allied Radio) and Alcoa type 804, with No. 64 flux, both available from Alcoa distributors. All hardware throughout was aluminum, except for the transmission line. The copper of the latter, in direct contact with aluminum, would result in harmful chemical action, so a plated cable lug was soldered to the transmission line, and this, in turn, to the aluminum, using ordinary 60/40 solder. Zinc-dipped lugs adhere to the aluminum solder very well.

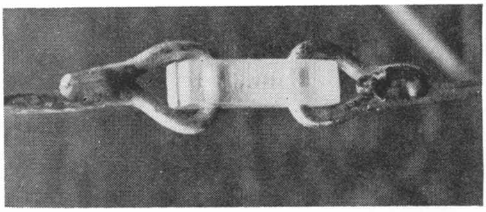
Feed Methods

Different types of baluns are needed for the two bands. The X-Q quad is voltage fed, so a balun with an impedance step-up is required. This is the conventional half-wave-loop type (left, in Fig. 3) commonly used in v.h.f. antenna work. The impedance of the X-Q quad alone would be quite high, but use of large-sized wire and three parasitic elements brings the feed impedance down to the vicinity of 200 ohms. The balun used with this array was made of RG-58/CU cable, cut for 145 Mc. It was wrapped with electrical tape to make it more rigid and durable. The balun loop is 27¼ inches long. If high power is to be used, the balun should be made of larger coax, such as RG-8/U.

The feed impedance of the 50-Mc. antenna is near 50 ohms, so a 1-to-1 balun is required. This is made as shown at the right in Fig. 3. A piece of the same 50-ohm cable as is used for the main transmission line is cut to 57 inches over-all, and taped to the line. At the end away from the antenna the outer conductor of the stub is shorted to the outer conductor of the transmission line with a piece of braid, as shown in the sketch. The inner conductor of the stub is severed at 38⅝ inches from the antenna end, by drilling through the coax. Use care to prevent shorting the inner and outer conductors together in doing this, and be sure that the inner conductor is broken. Check on these points with a continuity meter of some sort, before connecting the balun to the antenna. Note that in its completed form the inner conductors of the stub and the coaxial line are connected together, and the driven-element ends are connected to the outer conductors. Like the 2-meter balun, this one is wrapped with plastic tape to maintain electrical and mechanical characteristics. The need for larger cable for high-power operation also applies.

Tuning

The quads were tuned up at 51 and 145 Mc., in



Close-up of one of the element-and-stub assemblies, showing the aluminum soldering. The insulator is made in two pieces and cemented around the wire loops, after soldering is completed and the elements have cooled.

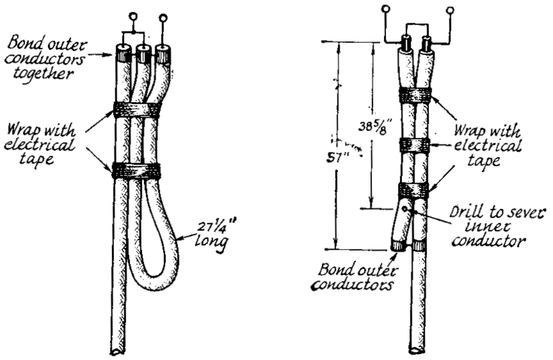


Fig. 3—The balun used for the 2-meter quad, left, is the conventional half-wave loop, giving a 4-to-1 impedance step-up. The 50-Mc. balun, right, is the 1-to-1 variety. The inner conductor of the stub is severed at the point indicated, by drilling carefully.

order to cover the portions of the bands most used locally. Adjustment procedure would be the same for other parts of the bands, if local usage so dictates. For convenience, a preliminary adjustment was made in the basement, by suspending the array about a foot below the ceiling beams and about the same distance above the floor. The arrays seemed to change only slightly when suspended out of doors, so getting them nearly to the right point indoors paid off.

A grid-dip meter was used to check the resonant frequency of the parasitic elements. The meter coil is placed alongside the vertical portion of the 50-Mc. element to be adjusted. It is a good idea to check the actual frequency of the g.d.o. by means of a calibrated receiver, as the close coupling needed to get a dip may shift the g.d.o. frequency appreciably. The director is resonated at 54 Mc. by trimming the stub to length, and the reflector to 48 Mc. by adjusting the position of the short.

Tuning of the 144-Mc. antenna is more of a problem in this respect. The meter coil should be held near the short on the stub, and monitoring of the frequency with a receiver is nearly a necessity. It may be possible to observe two dips, one the correct one and the other resulting from resonance in the open portion of the stub beyond the short. If this occurs, put a temporary short across the open portion of the stub to detune it from the region of the band. A pair of alligator clips connected back-to-back makes a good temporary short. The forward director is tuned to 150 Mc., the second to 149 Mc., the driven element to 145 Mc., and the reflector to 140 Mc.

If the array cannot be adjusted in the position in which it will be used, the next best thing is to put it about 10 feet above ground. The height will be more critical for the 50-Mc. portion than for the higher frequency, and a height above ground of a half wavelength at 50 Mc. will cause the least reaction on the antenna impedance. At this height the stubs can be reached with a stepladder.

Final adjustment is made for maximum front-to-back ratio, using received signals from fairly distant stations. The results with the 50-Mc. portion were fine this way, but the 144-Mc. work turned out to be somewhat confusing, and a re-check was made at the final height of 30 feet. Even at this height, there was a considerable variation in observed front-to-back ratio. This is a result of various factors. Nearby stations generally give lower ratios than more distant ones, probably because of scattering of strong signals from trees, buildings and wires. It also may be related to the polarization discrimination of the antenna and the one at the other end. S.w.r. readings were under 1.5 to 1 from 50 to 52 Mc., and 144 to 146 Mc.

The completed antenna may be sprayed with Krylon as a protection against weather and corrosive gases. The points of connection of the baluns to the antennas should be wrapped carefully with plastic tape, and this wrap may be lacquer sprayed.

Results

Many hams have accused the quad of having both vertical and horizontal polarization. This is certainly not true in the forward direction, though its polarization may not be as discrete as that of some other arrays. This is not necessarily a disadvantage in v.h.f. communication, as there may be considerable polarization shift in work over rough terrain. On the other hand, if both polarizations are desirable, the quad makes this possible more readily than most other arrays, by virtue of its symmetrical shape about the boom. To change to vertical it is merely necessary to rotate the boom 90 degrees in either direction.

Construction may seem difficult, but the array is built to last. The use of aluminum throughout is a factor in this, and the successful use of aluminum solder was particularly gratifying. Behavior of the quads on the air has been excellent, and signal reports have been consistently good, despite the modest height of 30 feet.

Tests with the antennas on the "wrong" band have shown that the 2-meter antenna has practically no response on 6, while the 6-meter antenna response on 2 is 20 db. below that of the 2-meter quad. These results indicated that a single feed line might be used without switching, so the two antennas were connected through a coaxial T fitting to a single line. No deterioration was noted.

It is recommended that cable larger than the

(Continued on page 152)

Interlaced Quad Array

(Continued from page 14)

RG-58/CU used by the writer be employed in duplication of this array, particularly if the line run is to be appreciable, or the power output of the transmitters is in excess of 100 watts. Finally, once the neighbors become accustomed to the sight of "the thing" in the air, the user will find that it performs very well for its size and weight, and he can be quite happy with his choice of something a little out of the ordinary in the way of v.h.f. antenna systems. QST