Getting db the easy way

a five element Quad Yagi for two meters

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Here is a beam that is easy to make, easy to adjust, and easy to erect. It has the gain of beams considerably larger in size. This lightweight simple array can be mounted on a standard TV mast and rotator where the larger more bulky arrays require a tower and a heavy duty (expensive) rotator. There are no phasing lines to be adjusted and no impedance matching transformers are necessary when 75 ohm coax is used.

Quads have been a source of confusion for some time. Though there have been several articles in print on the subject, few hams have felt that these published versions exploited the full possibilities of such a device. The January 1955 *QST* article on a twenty meter Quad using two single turn loops aroused my curiosity as to the results of throwing in a director in addition to the reflector.

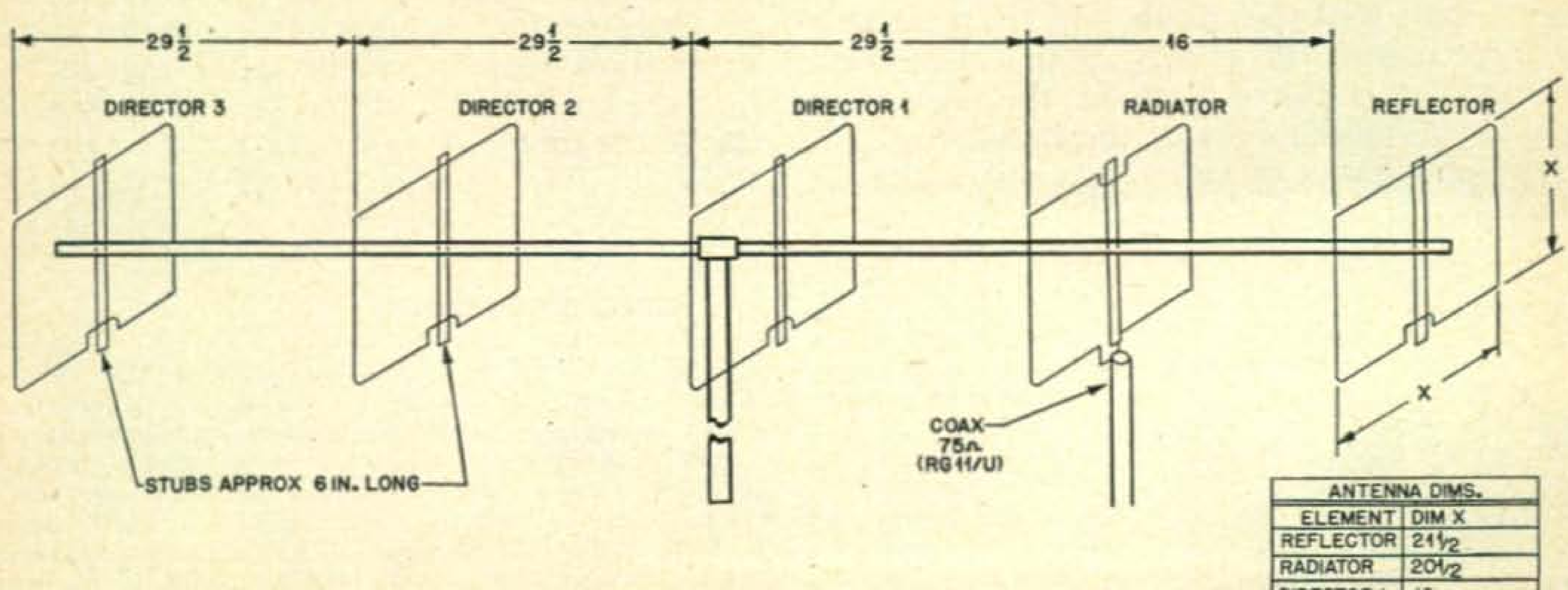
Investigation of the use of director loops was started in April 1955 with construction of a six meter beam using a Cubicle Quad with one director loop spaced at 0.2 wavelength. The six meter beam worked quite well and it was my belief that a worthwhile increase in gain was attained by adding a director loop. Further investigation of what could be done with more than one director was carried out on 144 mc rather than at 50 mc. To distinguish the design of this beam from others I decided to call it a Quad Yagi which is appropriate since it is a Quad beam with a number of parasitic elements as in a Yagi beam.

Facts & Figures

All of the information presented was found experimentally. Spacings of the elements were adjusted for optimum forward gain except for the reflector which was determined for best front to back ratio and is 0.2 wavelength, the same as was used in the earlier Cubicle Quad beams. Closer reflector spacing resulted in slightly lower gain and a broader pattern, while larger spacing caused a more rapid decrease in the gain but also generated minor lobes at the back corners. Spacing of the directors was adjusted for best forward gain and turned out to be ⅜ wavelength.

A dipole with a diode and a milliameter calibrated in db was used as a field strength meter to make gain measurements. Several measurements were made of the gain over a reference dipole at two different locations and a gain of between 13 to 14 db was obtained. This is about what can be obtained with a "Twin Five" Beam that is properly phased.

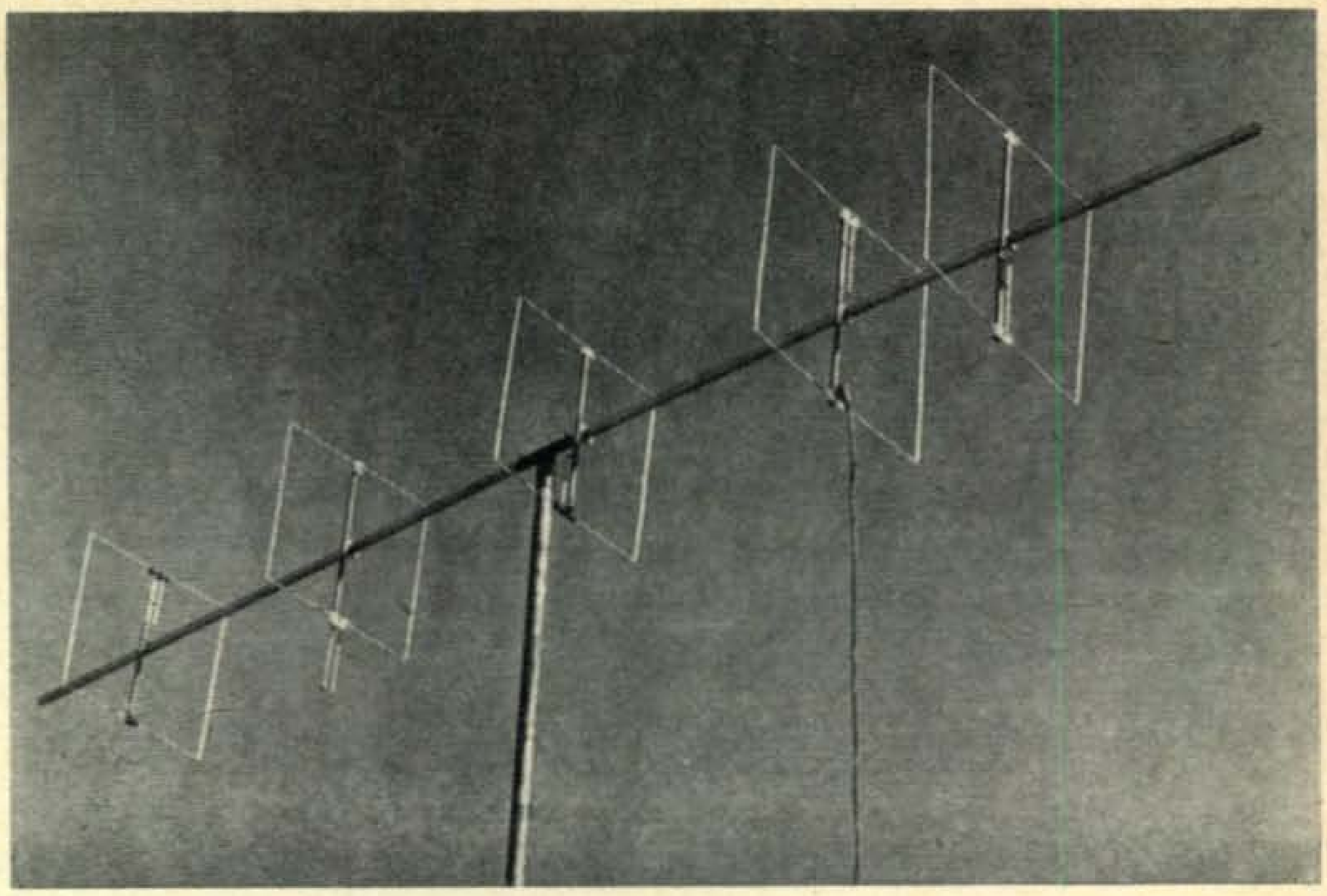
A rough plot was made of the field pattern of the beam and is shown in *Fig. 2* in comparison with a barefoot Cubicle Quad antenna to show the decrease in beam width caused by the addition of director loops. The front-to-back ratio was found to be about 45 db and the



ANTENNA DIMS.	
ELEMENT	DIM X
REFLECTOR	21½
RADIATOR	20½
DIRECTOR 1	19
DIRECTOR 2	19
DIRECTOR 3	19

Fig. 1. Construction information

Completed beam at W2MGF



front-to-side ratio was close to 60 db. The beam width at the half power points was about 30° in the horizontal plane and about 20° in the vertical plane.

Measurements of the S.W.R. with 75 ohm coax was made over the two meter band and was 1.04 at the frequency for which the beam was tuned. It increased to 1.5 at the high frequency end of the band. With the directors spaced at ¼ wavelength the S.W.R. was 1.02 at the low and rose to 1.4 at the high frequency end of the band. *Fig. 3* shows the curves ob-

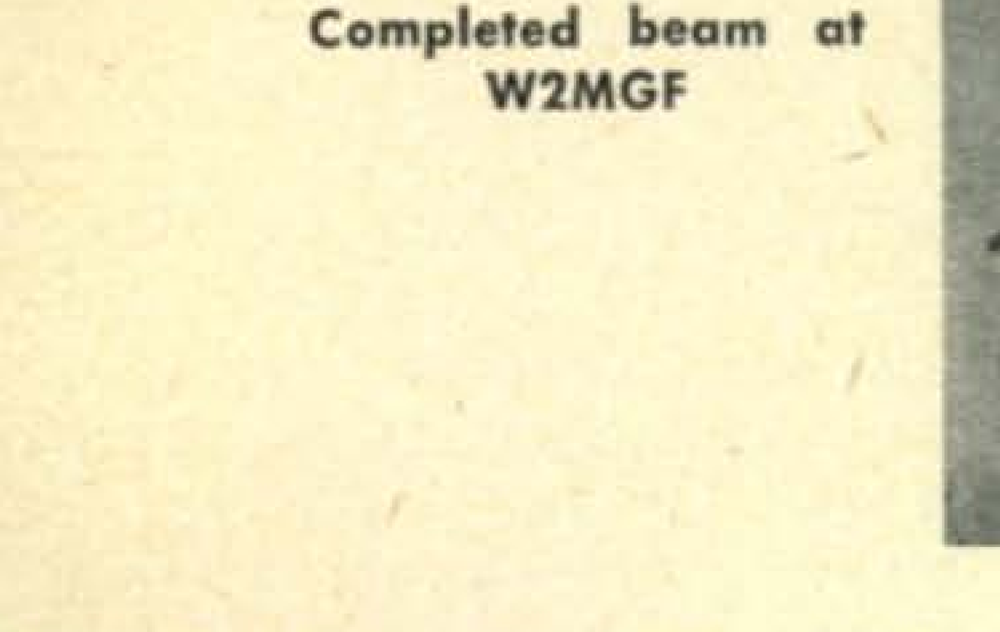


Fig. 4. Tuning indicator.

tained from these measurements. An unbalanced feed was used for the sake of simplicity, however a Balun should give better current distribution in the driven loop and might bring about a slight improvement of the gain.

Not only was the impedance match good over the 144 mc band, but the gain was constant across the band. The beam, though adjusted at 144 mc, performed equally well up to 148 mc.

From the experimental work with the Quad Yagi it was found that loop dimensions can readily be calculated. The length of the driven loop is one wavelength and its length is $L(\text{feet}) = \frac{984}{f(\text{mc})}$. This is longer than that of a straight wire in free space, which is due to it having no end effects. The design of my beam was calculated for loops slightly shorter than for free space length to allow each element to be tuned with a short stub. Directors were all made the same length and their stubs had sufficient tuning range for proper adjustment.

Construction

The construction of the beam is quite simple and can be made from readily available materials at low cost. All materials can be obtained from the local hardware or radio supply store at a cost of less than ten dollars. In figure #5 one loop is shown in detail. Dimensions of each loop is tabulated on *fig. 1*. Aluminum solid clothes line wire was used for the elements and is supported by ½″ fibre tubing. Dowel rod can be substituted for the support if it is treated to resist the weather. The aluminum brackets which hold the wire to the support are formed from sheet aluminum, and the mounting boom is 1″ dia. aluminum tubing both of which are sold in hardware stores by Reynolds "Do-It-Yourself" aluminum. Suitable mounting clamps for attaching the loops to the boom and also clamps for mounting the beam to the mast can be obtained at most T.V. supply houses.

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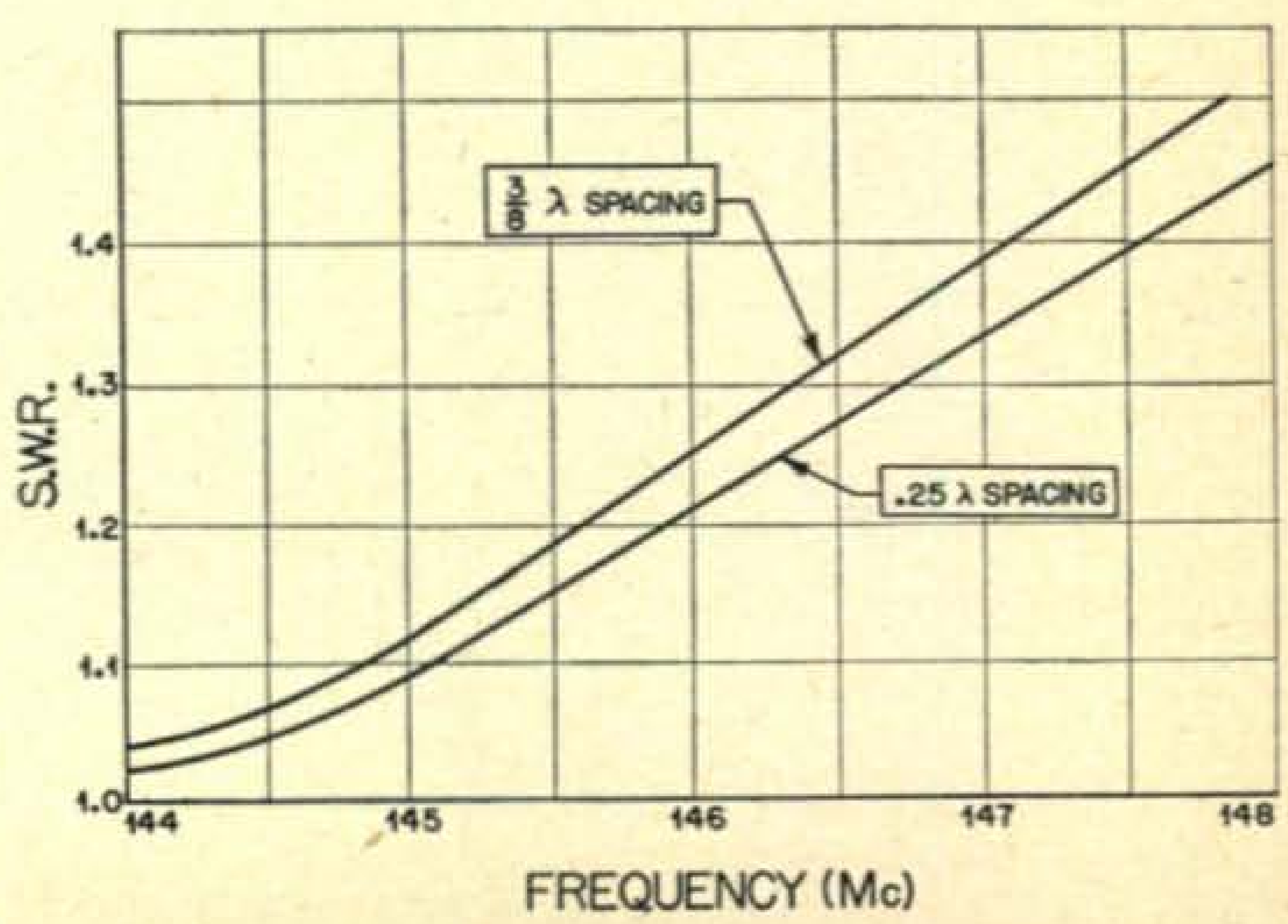

Fig. 3. S.W.R. v. frequency change.

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W4JUJ	1,210.	W8JAX	(conf.)	W9TKR	1,380.
W4WRH	813.75	W8JWX	31.25	W9YDQ	96.25
W4WSF	402.5	W8KPL	323.	W9YYG	243.75
W4ZPR	100.	W8RAB	143.	W9UTL	11.25
W4ZQK	900.	W8SDD	852.5	W9ZA	488.75
		W8SVL/6	15.		
W5GIF	52.5	W8UMP	675.	WØAIN	110.
W5ZWR	487.5	W8UPH	325.	KØAXH	297.5
		W8UVD	630.5	WØBQM	(conf.)
W6ACL	101.25	W8YPT	192.5	WØCDL	(conf.)
W6CLZ	110.			WØDUW	(conf.)
W6DAC	750.	K9BJV/WØHAW		WØGAX	1,045.
W6JVA	1,178.75		735.	WØIUB	875.
K6OHM	90.	W9BZW	1,687.5	WØQWS	488.75
W6QXF	(conf.)	W9CHD	420.	WØSGG	488.75
W6YBV	(conf.)	W9CNF	308.75	WØYJM	1,531.25
		W9CXY	1,017.5	WØYRY	531.25
W7CJZ	456.	W9GIL	20.	WØZBL	1,025.
W7FZB	11.25	W9GOC/SZR			
W7VIU/7	540.		1,687.5	VE2CP	373.75
		W9ITM	616.25	VE2IL	123.75
W8AJW	260.	W9KA	1,050.		
W8AQ	920.	W9KLD	725.	VE3AVS	320.
W8BDO	112.5	W9LNQ	1,207.5		
W8BMX	11.25	W9NH	520.	VE6SX	292.5
W8EKK	210.	W9RKP	231.		
W8JAE	(conf.)	W9RQF	807.5	VO6N	35.

QUAD YAGI

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Tuning the Beam

Tuning is easy. You will need a horizontal dipole with a diode and milliammeter connected as shown in *Figure 4*. The beam and pick-up

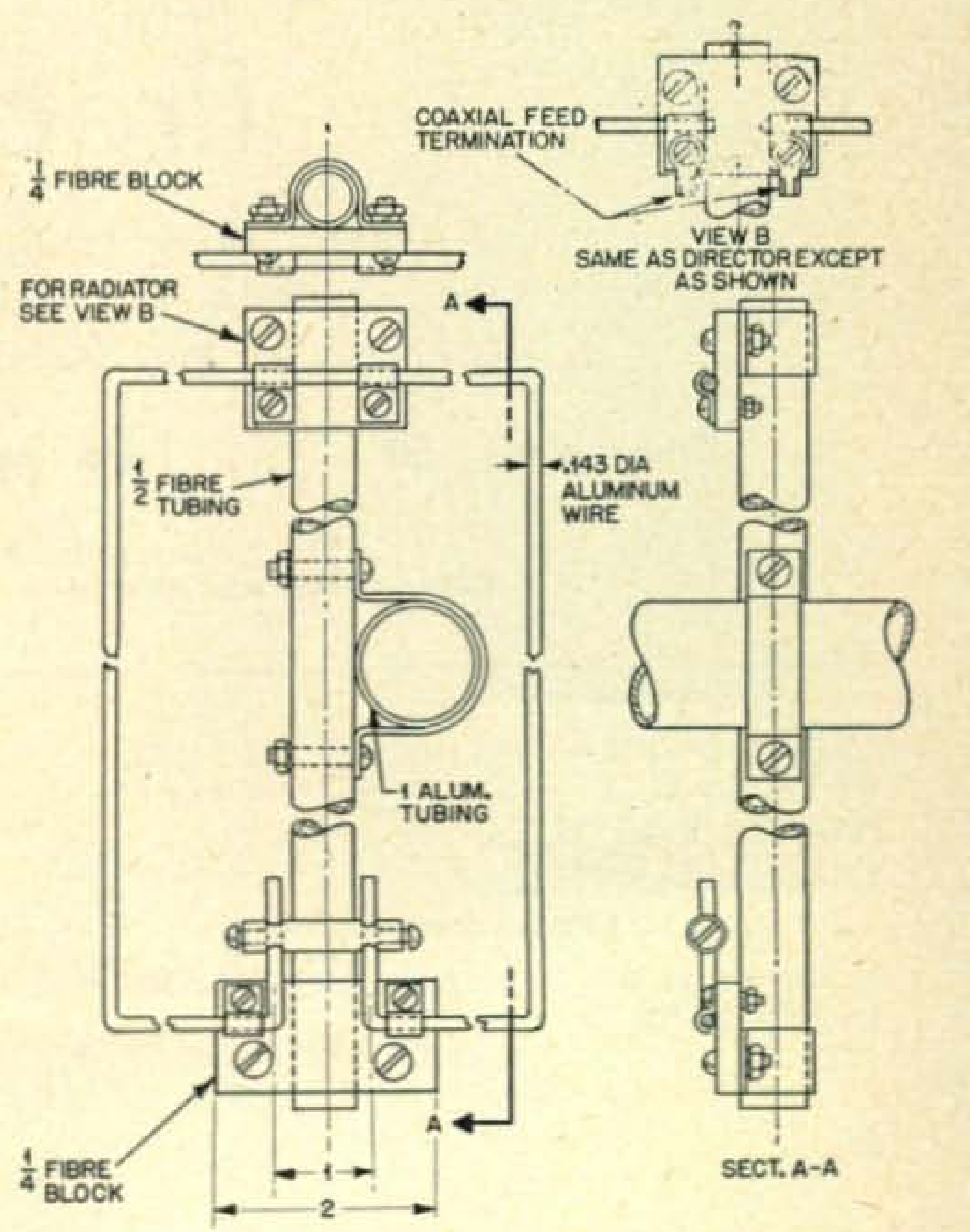

Fig. 5. Detail of one loop.

dipole should be set up about ten wavelengths or more apart, depending upon the power fed to the beam, and the procedure outlined below should be followed. ■

1. Set stubs of directors to shortest length.
2. Adjust driven loop for maximum meter reading.
3. Tune reflector loop for minimum reading with beam turned 180°.
4. Adjust first director, then each successive director for maximum reading.
5. Readjust driven loop for minimum S.W.R. or for maximum field strength which should coincide.

Adjustment of the reflector will have to be made with either the pickup dipole closer to

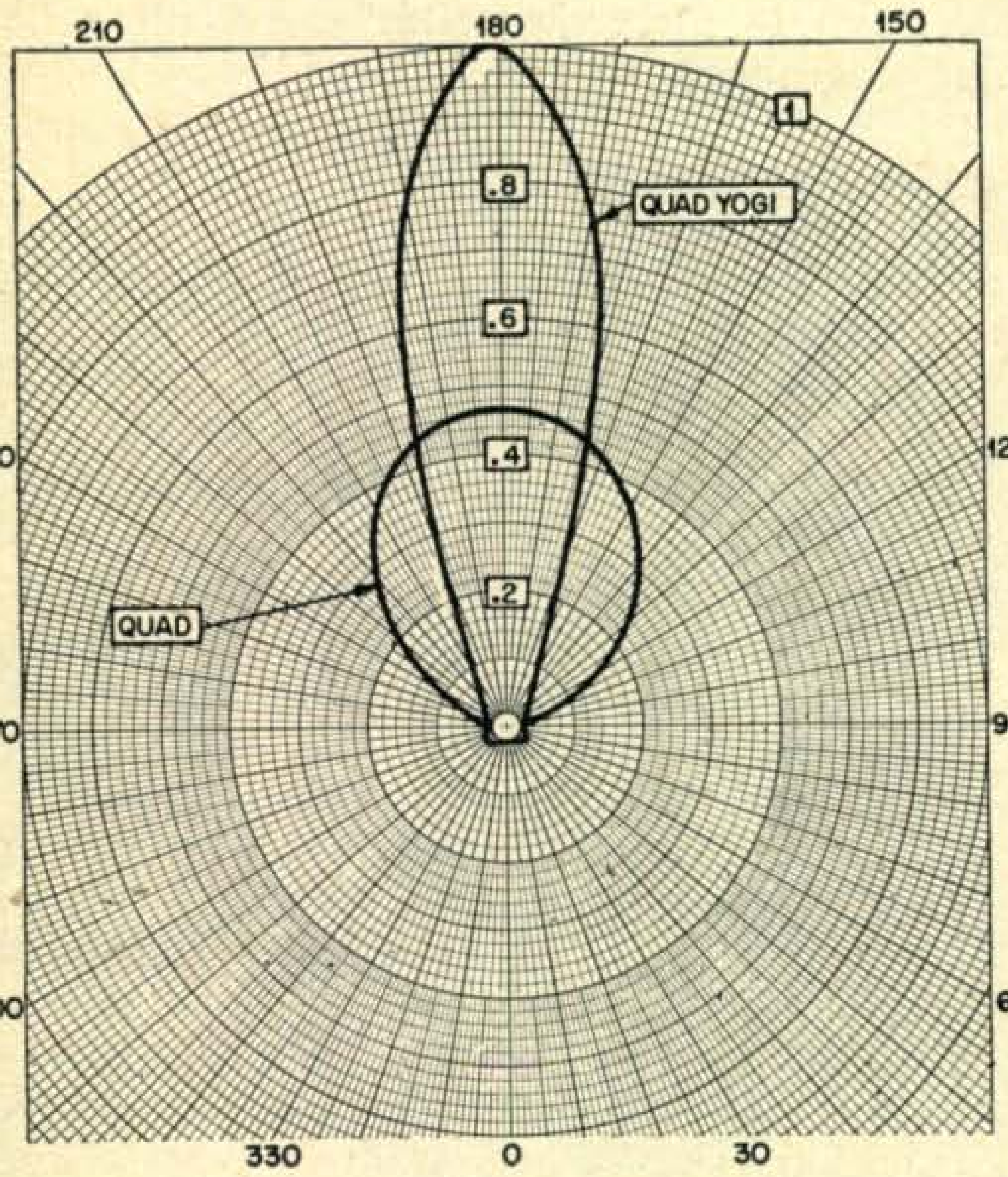

Fig 2. Reference gain.

the beam or a more sensitive meter. The adjustment of the elements are not critical except for the reflector which needs careful adjustment to obtain the best front to back ratio.

Operating Results

After several months of use on two meters the Quad Yagi has given very good results. Performance has been about equal to that obtained with a 20 element array consisting of two "Twin Fives" stacked horizontally. No direct comparison was made of the two beams since the 20 element beam blew down last fall which was one of the reasons for designing a new beam.

Future work on the Quad Yagi is anticipated and plans are to construct two seven element beams which will be stacked vertically. Work is presently being done to obtain more information on the behavior of the loops and an attempt is being made to analyze why and how it works.

I wish to extend my sincere appreciation to the people who have assisted me in this work and especially to Mr. Carl Schneideler (W2AZL) who has been most cooperative and helpful. ■