The G4ZU X Beam for 20

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This article presents a constructional variation of the well known G4ZU "Birdcage" which was also developed by G4ZU and originally described in the RSGB Bulletin. *This variation is becoming popular in Europe but is still relatively unknown here. It should appeal to many who want a beam but consider even a 2 element Yagi too large. Full size performance is obtained without the use of any loading devices and without any complicated tuning procedures. The model is constructed for 20 meters but the dimensions may be scaled for other bands.*

When the time comes to think about erecting a beam antenna, every amateur, either mentally or actually on paper, computes a "figure of merit" for various beam configurations as applied to his particular situation. Usually on the plus side in calculating this "figure of merit" are the main factors of forward gain and front-to-back ratio and these are balanced against the minus factors of cost, constructional difficulties, tuning difficulties, size and appearance. Many amateurs would like to enjoy the advantages of a beam but after evaluating the various types—G4ZU Birdcage, Quad, 2 and 3 element Yagi, *etc.*, and the various types of construction and element shortening variations, conclude that a beam isn't worth the work involved or the stir that it would cause in the neighborhood. Where even a 2 element Yagi rates a minus, the X beam may be just the answer.

Electrical

Figure 1 shows the basic configuration of the X beam. It consists simply of two elements—a driven element and a director. The total lineal length of both elements is slightly longer than the equivalent elements in a 2 element Yagi. There are several ways to look at the configuration. It may be regarded as half of a G4ZU "Birdcage" design with the length of the elements slightly increased in order to achieve proper resonance since the elements are partially folded back on themselves in the same plane. Also, the extra length of the elements can be thought of as performing a transformer action in order to maintain the high current points of the antenna at the maximum element spacing (¼ λ tip to tip) while raising the feed point impedance. The fact that this works out to an almost purely resistive feed point impedance of 50 ohms makes feeding the beam with coax possible without any special impedance matching networks.

Construction

The real beauty of the configuration becomes apparent when one considers the mechanical problems involved in putting the beam together. First of all, the turning radius is only 12 feet—not quite as good as the full-size G4ZU "Birdcage" but much better than that of a normal

The X beam for 20 meters installed on the roof at DJØBV. The rotator is in the attic.

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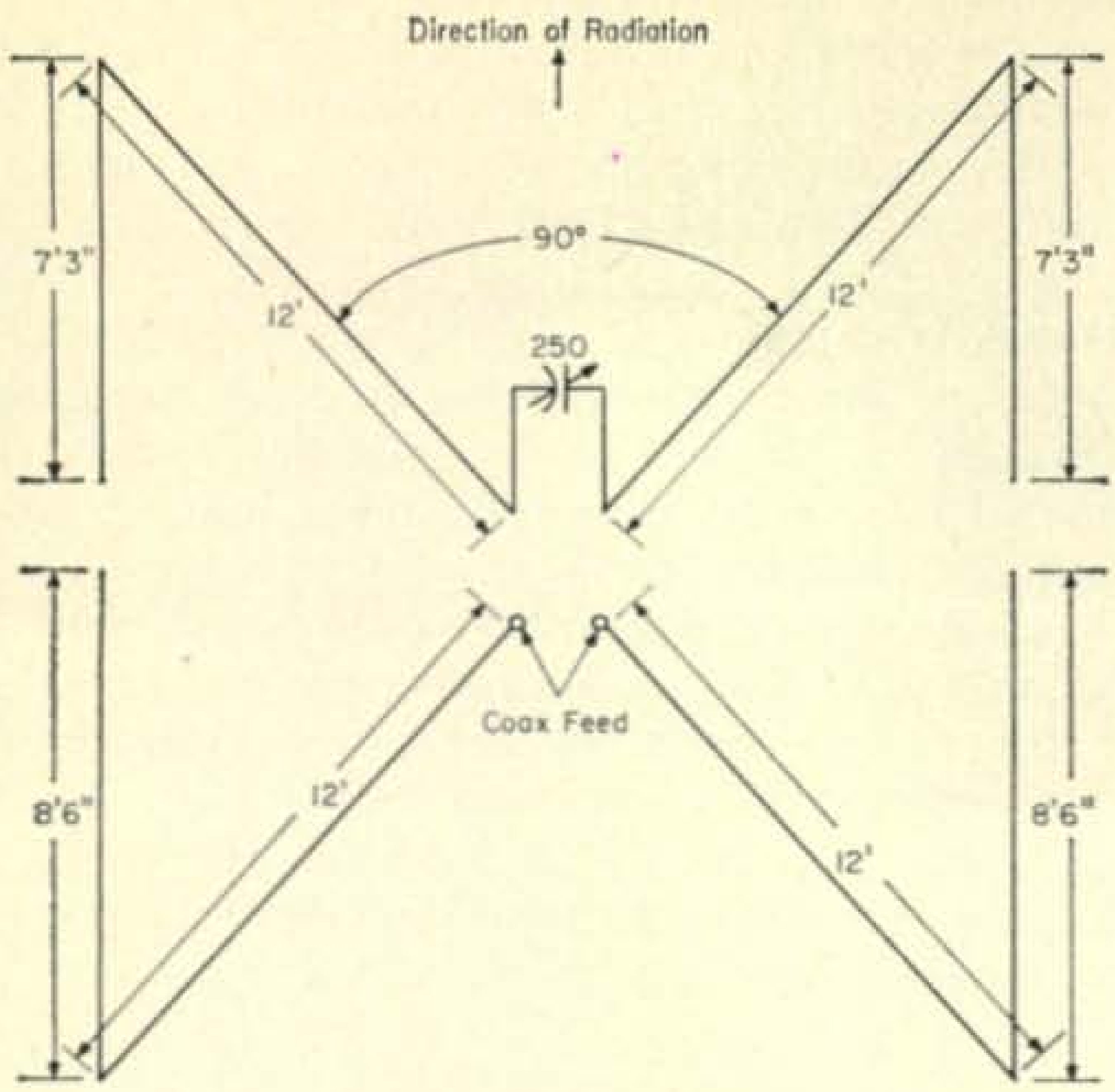


Fig. 1—X beam element dimensions. Direct coax feed (52 ohm) may be used or a Balun as explained in the text. The 250 mmf variable is a close-spaced receiver type.

Yagi. No boom is required and no long mast is required as by the full-size G4ZU beam or a Quad. The weight on the mast is balanced which also contributes to the overall mechanical stability.

There are many methods to attach the four element arms to the mast. Figure 2 shows how I did it. The two angle irons are each 36 inches long and of 1/8" stock. The iron reinforcing plate is 6" square and 3/16" thick. The pipe stub is 1 7/8" diameter and was chosen to fit snugly over the 1 5/8" diameter main mast. Secure attachment is made to the main mast by means of two stove bolts. The two pieces of angle iron are notched as necessary to allow them to fit over each other and allow the pipe stub to fit. All pieces and the reinforcing plate are welded together as shown. Many other methods of attaching the element arms to the mast are, of course, possible.

The four element arms are insulated from the

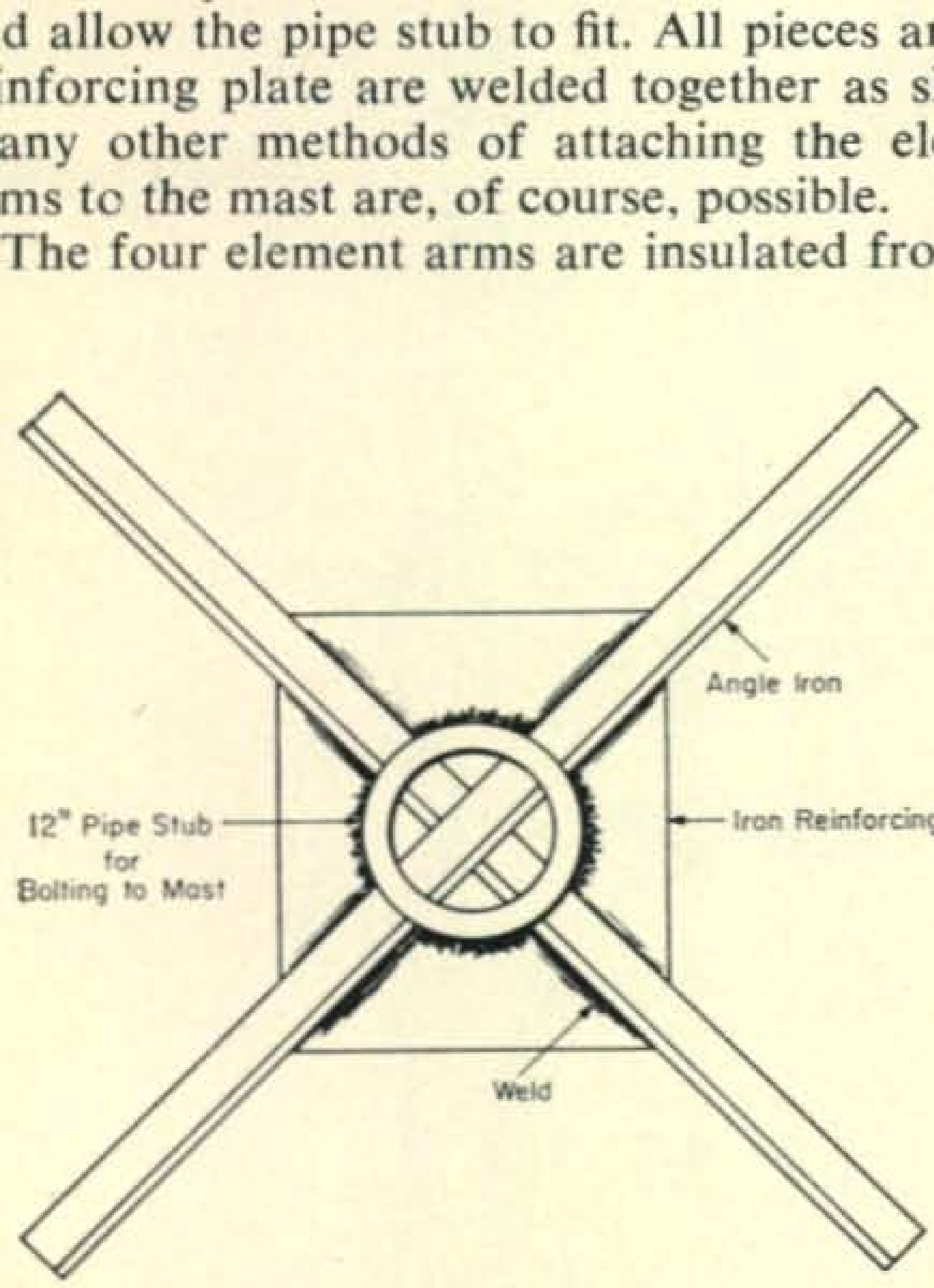


Fig. 2—Diagram of the basic element mounting cross. Material specifications are given in the text. The entire assembly should be painted, after welding, to prevent corrosion.

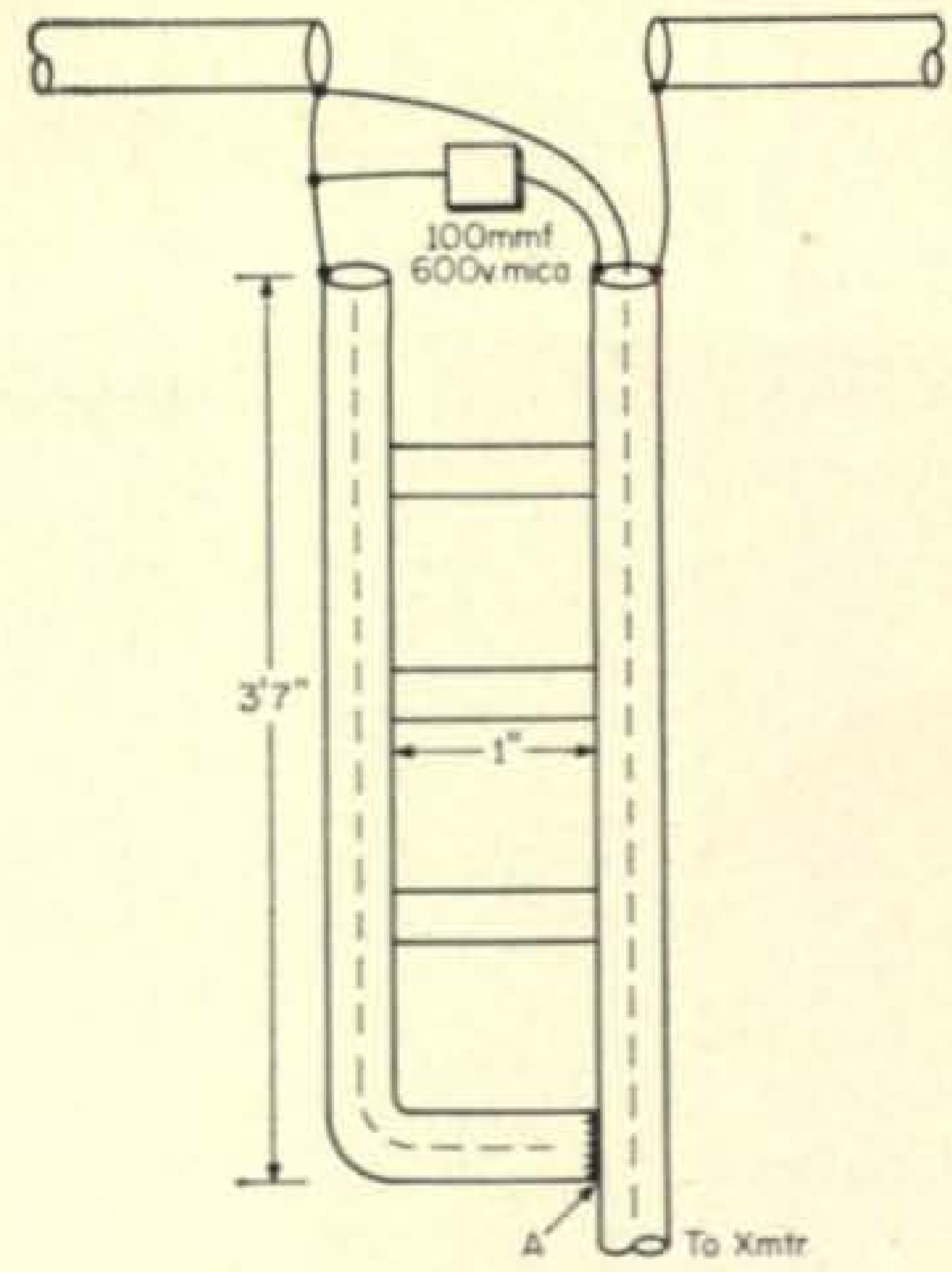
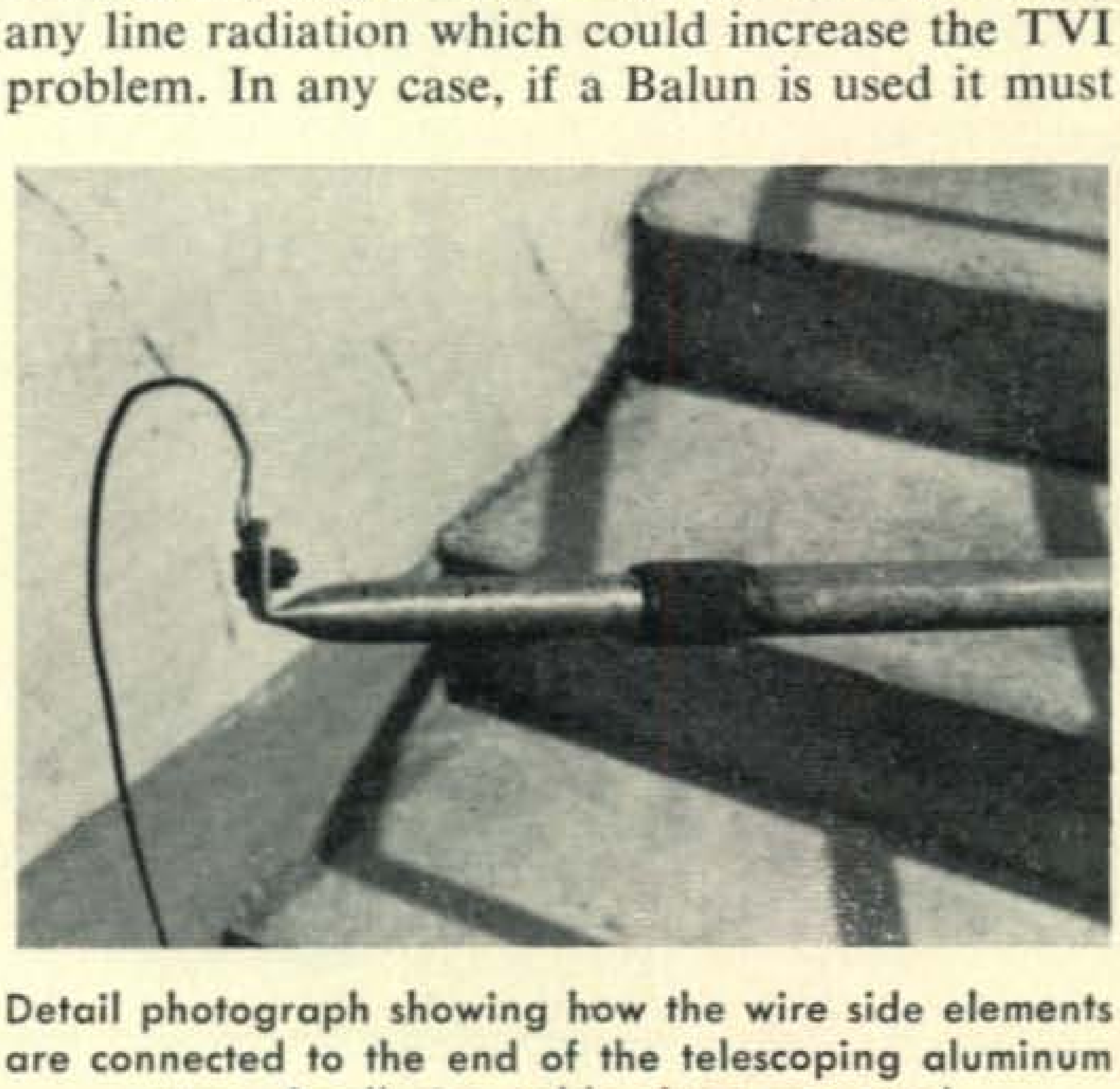


Fig. 3—Dimensions of the shortened Balun for use with the X beam. A normal size Balun should be used if mast length allows. Coax may be RG-58/U or RG-8/U and the capacitor is a 100 mmf 600 volt mica. The two coax lengths are separated by 1" wooden spacers. At point A only the shields are soldered together; the inner conductor of the Balun is not connected at either end.

mounting cross by means of plastic industrial hose passed over their ends. Attachment to the cross is by means of radiator hose clamps as shown in the photograph. The r.f. quality of the insulation at these points is not critical since they are all low-voltage r.f. points.

The driven element is fed with 52 ohm coax through a shortened Balun transformer, the dimensions of which are given in fig. 3. The shortened form of a Balun was used only because a normal length Balun would have been longer than the mast section extending from my house roof. It is not absolutely necessary to use a Balun with the beam anymore than it is necessary with a dipole. Since the antenna is basically a balanced one, the use of the Balun may prevent some minor pattern distortion when the beam is fed with coaxial cable as well as reducing any line radiation which could increase the TVI problem. In any case, if a Balun is used it must



Detail photograph showing how the wire side elements are connected to the end of the telescoping aluminum arms. Small size cable shoes are used.

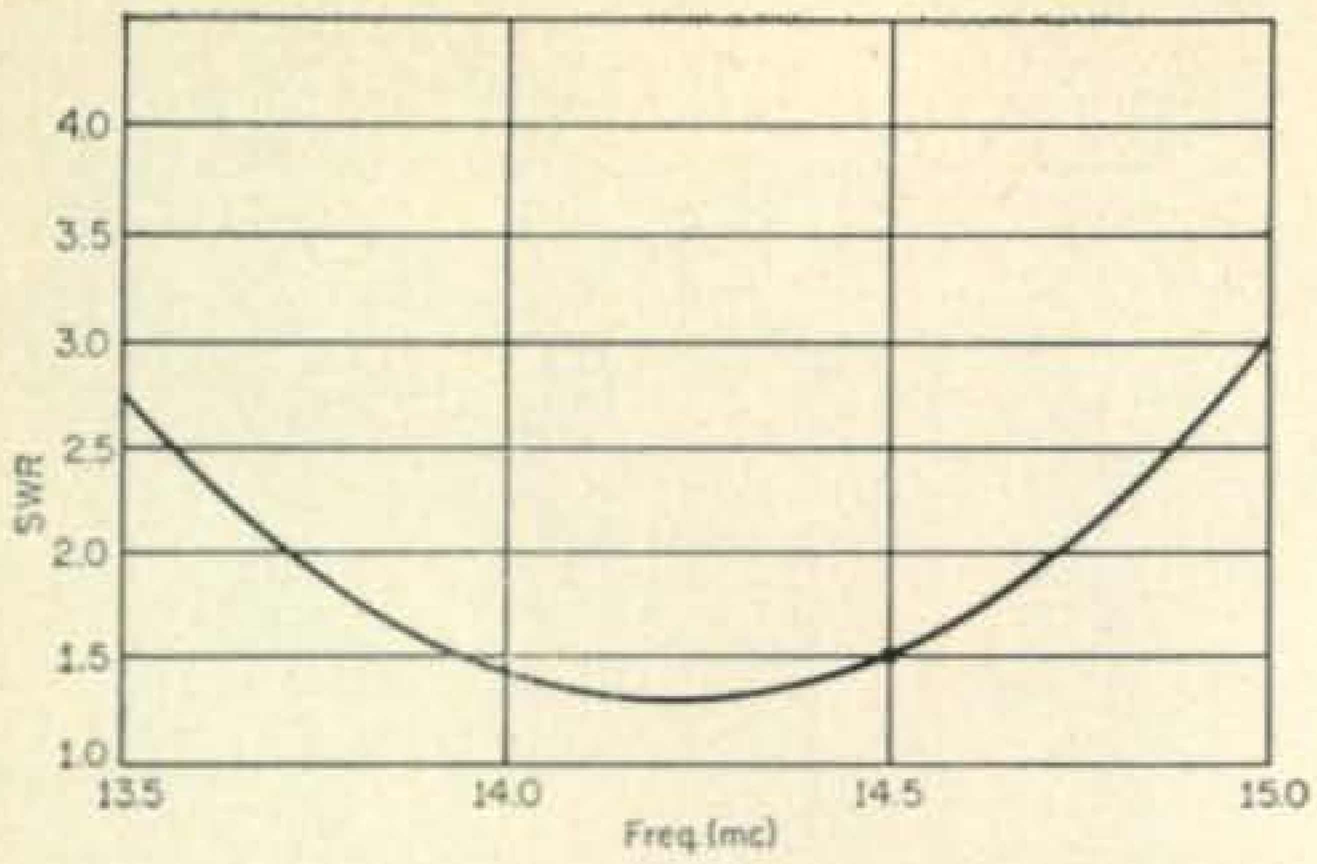


Fig. 4—S.w.r. curve of the 20 meter X beam fed with 52 ohm coax.

be held away from the mast a few inches for its entire length if it is to be effective.

A 250 mmf receiver type variable is mounted in a plastic box which is secured to the mast by another hose clamp. The capacitor is connected in series with the two halves of the director element in order to provide for tuning.

The element arms used for my beam are composed of 4 telescoping pieces of aluminum tubing—1⅛, 1⅞ and ¾ inches. The first three sections are each extended to just slightly shorter than 4 feet each and the last ¾" section, which is just long enough to make a total length of 12 feet, is bent for attachment of the side wires. The side wires are normal stranded antenna wire although copperweld would probably be better since the stranded wire may tend to fray at the point where it is attached to the element arm tips. The construction of the beam with 4 telescoping sections of tubing for each arm is far more elaborate than necessary and just two 6 foot sections of telescoping 1" and ⅞" aluminum tubing, for example, would be perfectly satisfactory.

Tuning

Tuning of the antenna is extremely simple and almost takes longer to describe than it takes to perform. The s.w.r. of the driven element should first be checked. A curve very similar to that shown in fig. 4 should be obtained if the beam is reasonably high, about 30 feet, and in the clear. The beam is quite broad as shown in fig. 4 and no adjustment of the driven element should be necessary. Of course, if any other type of feed besides 52 or 72 ohm coaxial or balanced cable is used, some sort of matching network is necessary. Tuning the director is most easily accomplished by having a friend listen to your signal and with the beam aimed in his direction, peak up the director tuning capacitor for maximum forward gain.

A further, but not absolutely necessary, step would be to then turn the antenna 180 degrees and retune the director tuning capacitor for minimum signal (best front-to-back ratio). The settings of the capacitor for these two conditions should be about the same. If there is some small noticeable difference in the settings, as would be normal for most beam designs, one simply has to decide if maximum forward gain or best front-to-back ratio is most important. A loss of ½ db forward gain may well be worth an improvement of several db in the front-to-back ratio if one is trying to work weak DX with strong QRM coming in from the opposite direction. For most circumstances, however, where the beam is rotated and varying QRM patterns in different directions are encountered, tuning for maximum forward gain is the simplest expedient. I have not tried to plot the actual beam pattern but judging from the relatively broad forward lobe and the relatively narrow but deep rejection slot to the rear observed, I would guess that the pattern must be very similar to the cardiod obtained when two half-waves are spaced ¼ λ and fed 90 degrees out of phase. The forward gain and front-to-back figures users of the beam usually quote also seems to confirm this type of pattern.

Performance

I cannot say, as some antenna articles usually do when describing performance, that even with the beam only several feet off the ground and 10 watts input that I immediately received 599 reports from VQ9 or some other DX. I didn't even try the beam when it was only several feet off the ground. I will say that when the beam was properly installed and tuned, that it performed much better for DX than my previous ground plane and it fully repaid the time it took to build it.

It will equal or outperform, under the same conditions of installation, a full-size, close-spaced 2 element Yagi and, on the band for which it is cut (20 meters), most of the trap-type, multiband beams on the market. The forward DX

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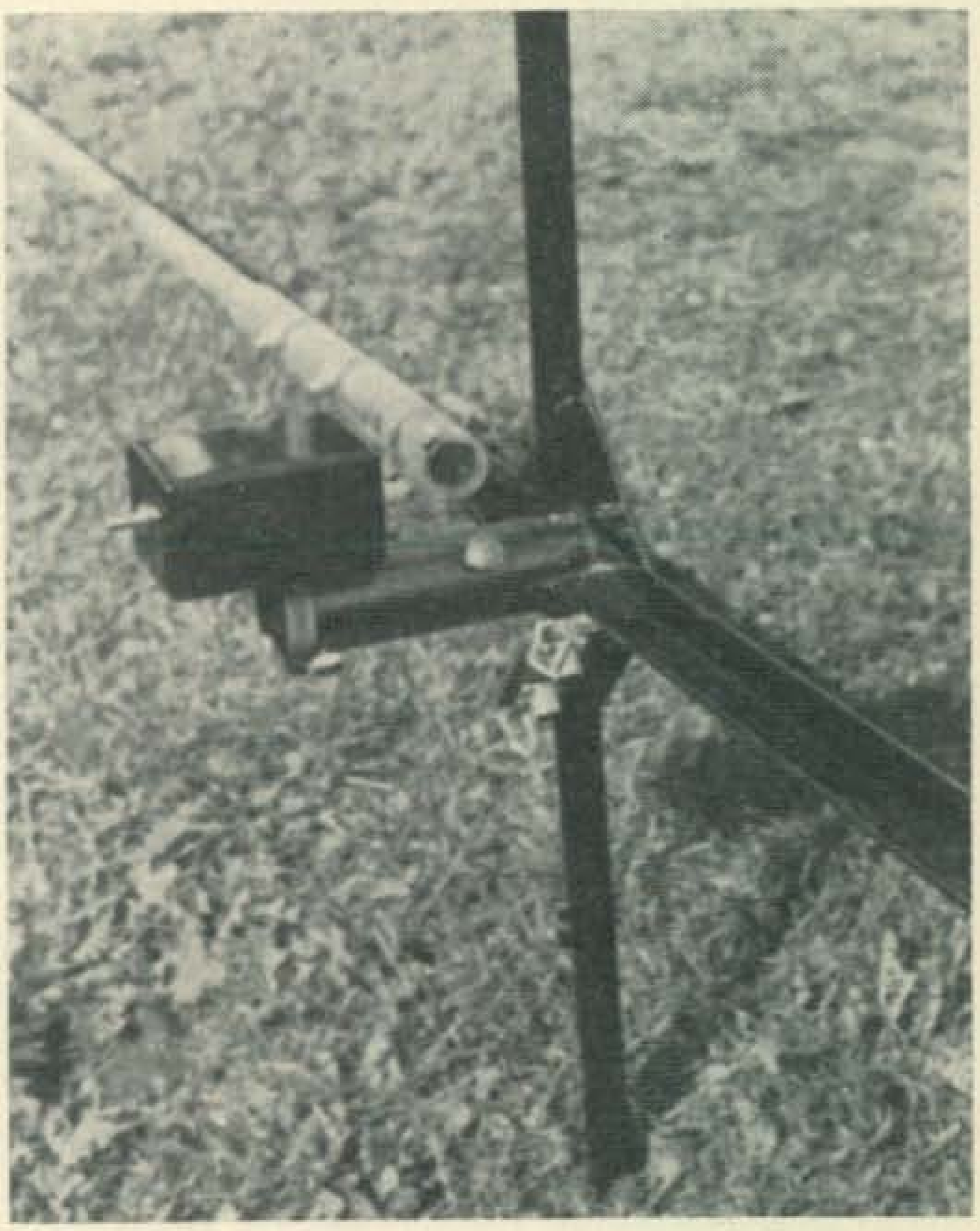

The element mounting cross. Large size industrial hose is used to insulate the elements.

The power supply and the control unit each contain an operating bias adjust pot. Let us say that the optimum tube current is found to be 20 ma. Turn the CONTROL UNIT pot to maximum current and then set the power supply pot to give the 20 ma. Lock it in place. Now the Control Unit pot may be used as an R.F. GAIN control, varying the 7788 from cut off up to optimum current, without the need for a meter to constantly monitor 7788 current.

Measured Performance

Overall Gain	$\approx$ 30 db
Gain Reduction with R.F. GAIN control	$>$ 50 db
Image Response	$>$ 70 db
Spurious Responses—20 to 100 mc	$>$ 55 db
Spurious Responses—100 to 200 mc	$>$ 70 db
I.F. Feedthrough	$\approx$ 80 db
Overload point above noise[3]	$\approx$ 70 db
Gain change[4]	$\approx$ 8 db
Noise figure[5]	2.8 to 3.6 db

[3]Defined as signal strength required to cause cross modulation with a weak signal approximately 10 db above the noise and 200 kc away.

[4]The Gain Change is measured over 2 mc portion of the band when peaked at 144.2 mc.

[5]The range of 2.8 to 3.6 db on the noise figure depends upon the noise generator correction factor used.

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gain measures 5-6 db and the front-to-back ratio is 18 to 20 db. It will definitely take a back seat to the full size G4ZU "Birdcage" or a Quad but it is a good performing beam and it will definitely get you into the "ballpark" which is reserved for the beam fraternity.

Variations

Other variations have to do with trying to ground various elements of the beam to avoid any insulation difficulties. GM3HMU, for instance, works his X beam with the director elements directly connected to the mast as originally developed by G4ZU. He reports fine performance with the beam dimensioned as given without any need for tuning the director. Of course, tuning of the director can still be accomplished by varying the length of the director arms as a "plumbers delight" Yagi is tuned. One could go a step further and also connect the driven element directly to the mast as was suggested by G4ZU in his original "Birdcage" article thus making a "plumbers delight" version of the X beam. With this construction, the driven element would then have to be fed through a "T" or "gamma" matching arrangement. I have not tried this type of construction but there is no reason why it should not work the same as it does with other beam types. I would be most interested to hear from anyone who does construct the "plumbers delight" version.

I wish to especially thank G4ZU and GM3-HMU for all the information they supplied about the X beam and which resulted in my experiments with the design. Leave it to the English and the Scotch to squeeze the most out of the least! ■