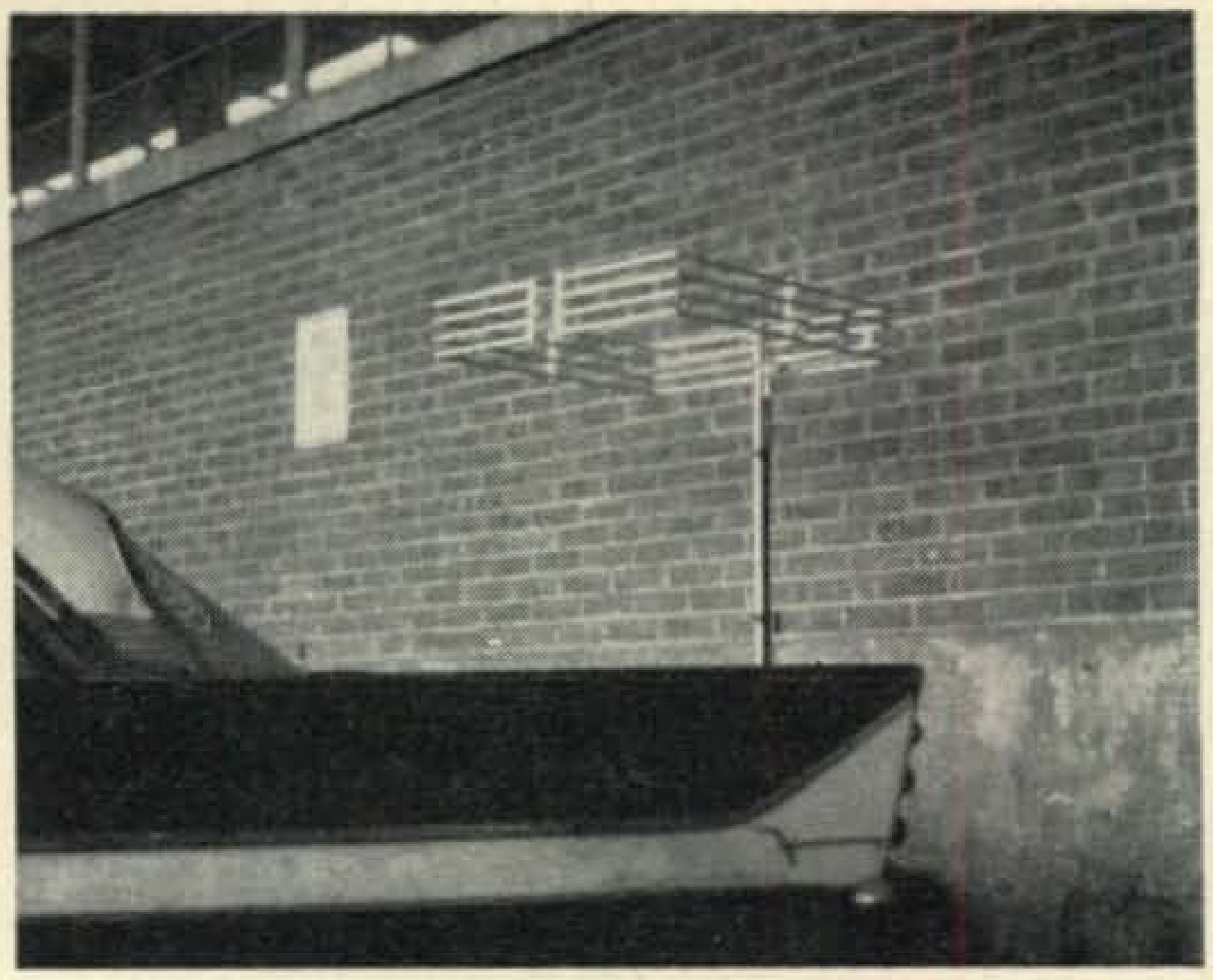
View of the Four Square Six antenna mounted on the car.



A Four Square For Six Antenna

BY JESS DAUGHTREY,* K2EEM

This mobile antenna is only slightly larger than the average halo and has two advantages. First, it has a wider bandwidth and second, the square shape tends to merge with the car and thus be less obtrusive.

THE problem with most six meter halos is the limited frequency range that can be covered without the s.w.r. becoming objectionably high. The reason for this narrow bandwidth is rather simple. If a halo were cut, like a beam, to a half wavelength and folded into a circle it would have a probable diameter of 38 inches, much too large to mount on a car. The average halo is made smaller than a half wavelength with the result that it is self-resonant somewhere near 75 megacycles. When it is rolled into a loop and the ends brought close together it is capacitively loaded with large end discs to bring the frequency down into the 6 meter band.

The capacitive loading makes the antenna a very high Q device and consequently it is very critical of resonant frequency.

Harry Douglas, W2VRU, had the idea of making the antenna square which would reduce its physical size and still retain the omnidirectional characteristics of the round antennas. He is the one who designed and built the first "Four Square Six."

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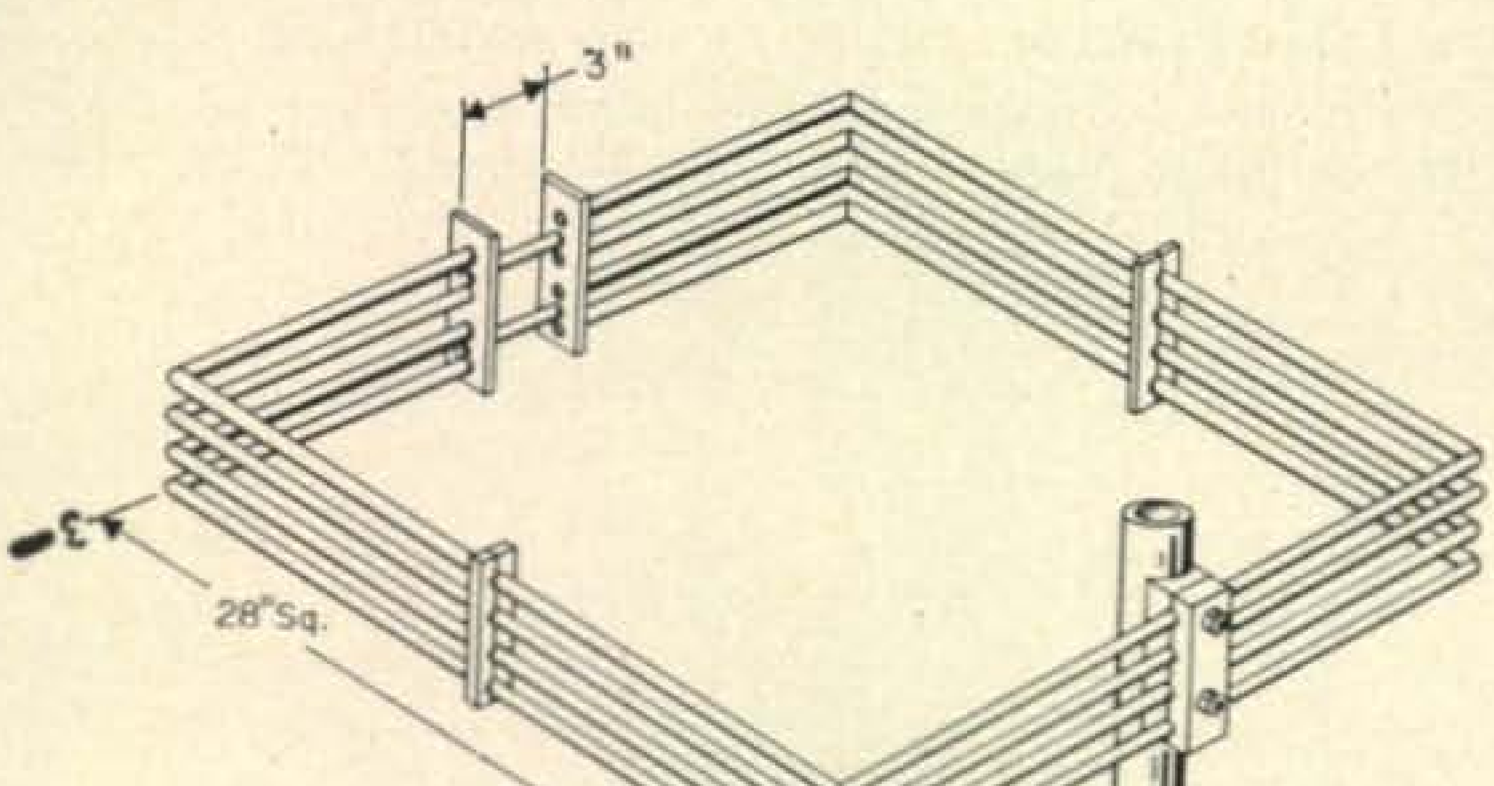


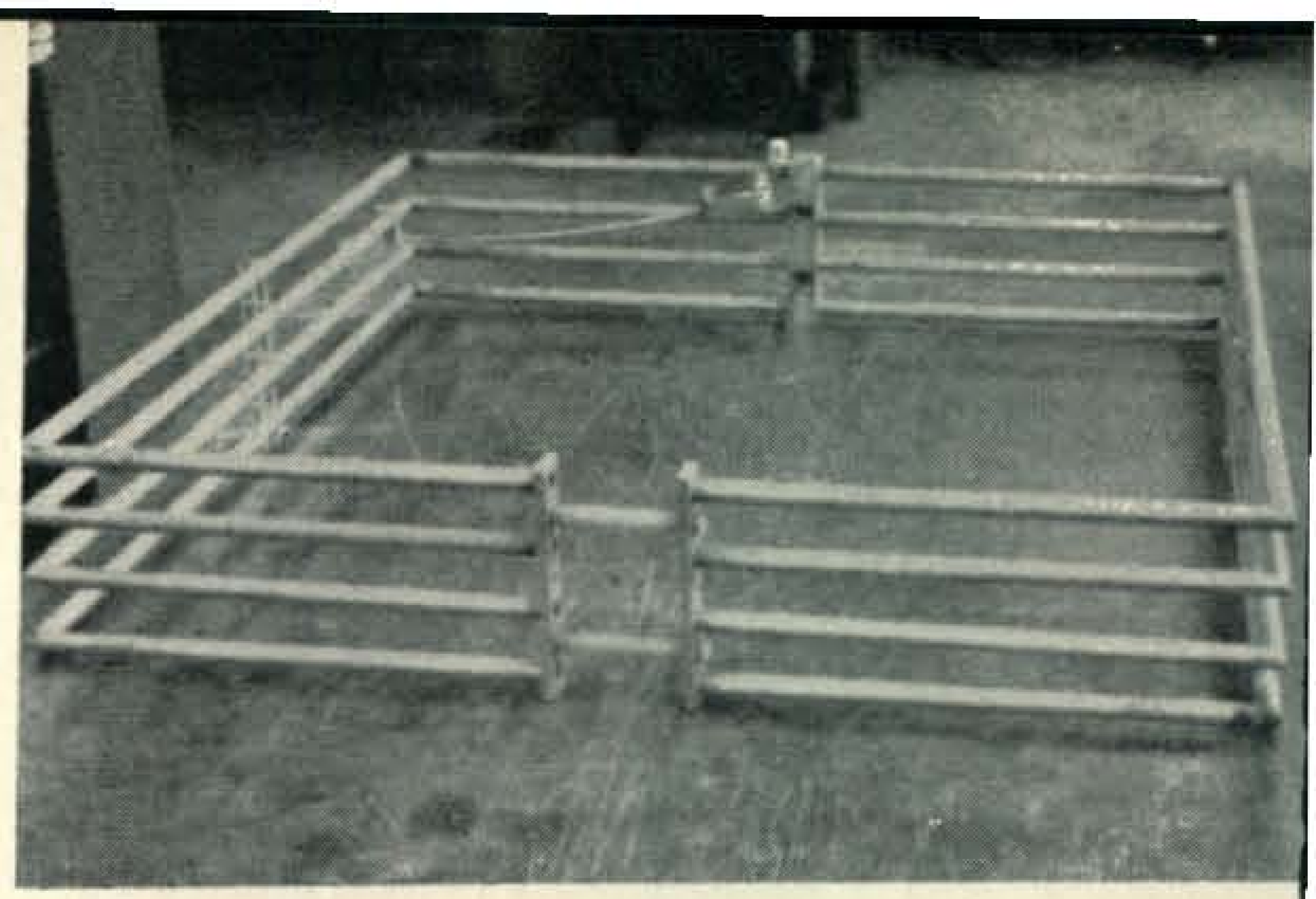
Fig. 1—The 6 meter mobile antenna is made from ½" o.d. 0.50 wall aluminum tubing (6016-T6), mitered and brazed at the corners. The measurements are 28" center line to center line or 28½" overall. The insulating material at the 3" gap is described in the text.

No matter how good a mobile antenna might be, it meets with two distinct disadvantages as compared with fixed station antennas. It has to work in close proximity to the ground and has to contend with the car body acting as a reflector. Harry first tried his idea in his lab on a three kmc, single element version. Then came the first six meter antenna, one of the elements of the Four Square Six. This antenna proved tremendously successful, and later the other elements were added to increase the capture ratio on receive, and also to reduce the I^2R losses during transmit. The gamma match was used rather than a matching coil so that all the elements could be connected to the mounting block for mechanical strength.

Test results with this little gem were very gratifying. With the antenna resonant at 50.5 megacycles, the maximum s.w.r. between 50.0 and 51.0 mc was 1.5 to 1. With so little activity at the higher frequencies, in the six meter band, we both decided upon 50.25 as an ideal center frequency. Even at this, I run about 1.6 to 1 at 50.8 mc, the AREC net frequency. The only comparisons that I am able to make are those made with the conventional halo that I formerly used. The halo was equipped with an impedance matching transformer and ran an s.w.r. of 1.1 to 1 at 50.25 megacycles, the resonant frequency. At 50.17 the s.w.r. was about 1.35 to 1 and at 50.3 it was 1.3 to 1. At 50.4 the s.w.r. was up to 2.0 to 1 and at 50.8, the AREC net frequency, it was 8.5 to 1.

Advantages

There are a few other interesting advantages to the Four Square Six. When it would rain, the



The completely assembled antenna is now ready to be mounted on the car. The polystyrene side spacers are just visible.

s.w.r. of the halo at the resonant frequency, would increase to 3.0 to 1. This was because the rain between the capacitor plates would, in effect, make them closer together increasing the capacitance, and the resonant frequency of the antenna would be lower. The Four Square Six has almost no capacitance to vary, and the worst wet antenna s.w.r. value encountered was 1.3 to 1 at the resonant frequency.

There is a fast QSB experienced with the halo that is caused by the capacitor plates vibrating and varying capacitance. This is also eliminated with the Four Square Six.

I guess the most important reason for liking the Four Square Six better is that the XYL finds it less objectionable. She says, "Even though it is larger, it seems to blend in better with the lines of the car."

Construction

This is one project that I would suggest not to start without first recruiting the services of a machine shop. Someone who can do aluminum brazing is also a necessity.

The antenna is made from ½ inch o.d., .050 inch wall thickness, hard, (6061-T6) aluminum tubing. The antenna is 28 inches square "on the center line." When ordering the tubing, be sure to allow for the 28½ inch overall measurement. There will be twelve pieces 28½ inches long with both ends cut at a 45 degree angle. There will be eight pieces 12¾ inches long with the angle cut on one end only. Three long pieces and two short, then, are assembled, and brazed together to form one element. A simple brazing jig could be used to keep the elements uniform during brazing.

I recommend brazing rather than aluminum welding, because it has been my experience that welded aluminum is more likely to be weakened at the edges of the weld. This could cause the elements to break, eventually, at that point.

End Pieces

The end pieces which connect the ends of the elements are made from 1 inch wide aluminum strip ¼ inch thick and 5½ inches long. The holes for the elements are drilled through the bar and the set screw holes are drilled and tapped. Set screws were used because welding at this point would increase the probability of a break from the elements vibrating. I would suggest the use of stainless steel hardware throughout to prevent trouble later.

The ends of the elements are left open to reduce the area of the strips facing each other and thus decrease the capacitance between them.

The spacers for the gap are about ¾" in diameter and are made of either polystyrene, polyethelene or teflon. I used the polyethelene from the center of a piece of RG-94/AU coaxial cable.

Side Braces

The side braces are made from polystyrene sheet. I would suggest ⅜ or ½ inch thick. Mine is ¼ inch thick and should be stronger. I would not recommend lucite or plexiglass be used, because I feel they would have too high a loss at 50 megacycles.

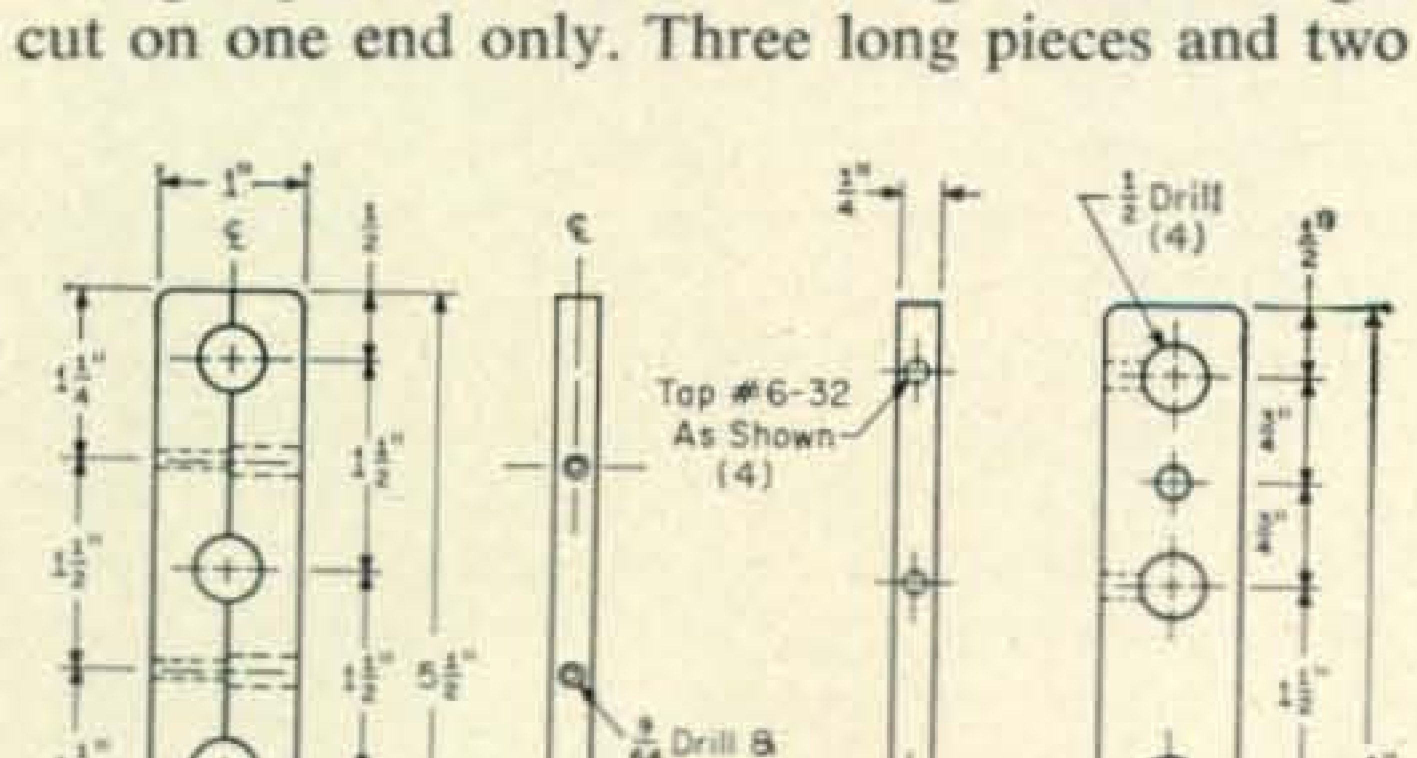


Fig. 2—(A)—The side braces are made from ¼" polystyrene. The clamping screws should be 6-32 nylon, (B)—the two end pieces are made from ¼" aluminum (6061-T6)

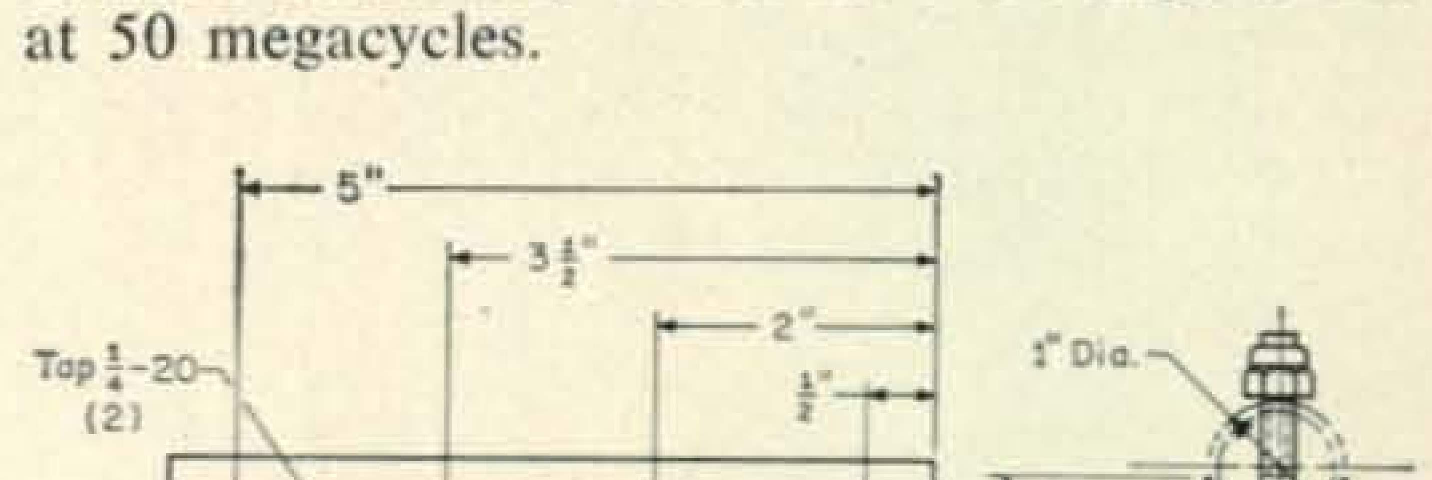


Fig. 3—Details of the mast clamp which is made of aluminum. The ¼-20 socket head screws are used to hold the mast to the clamp and are secured with elastic stop nuts.

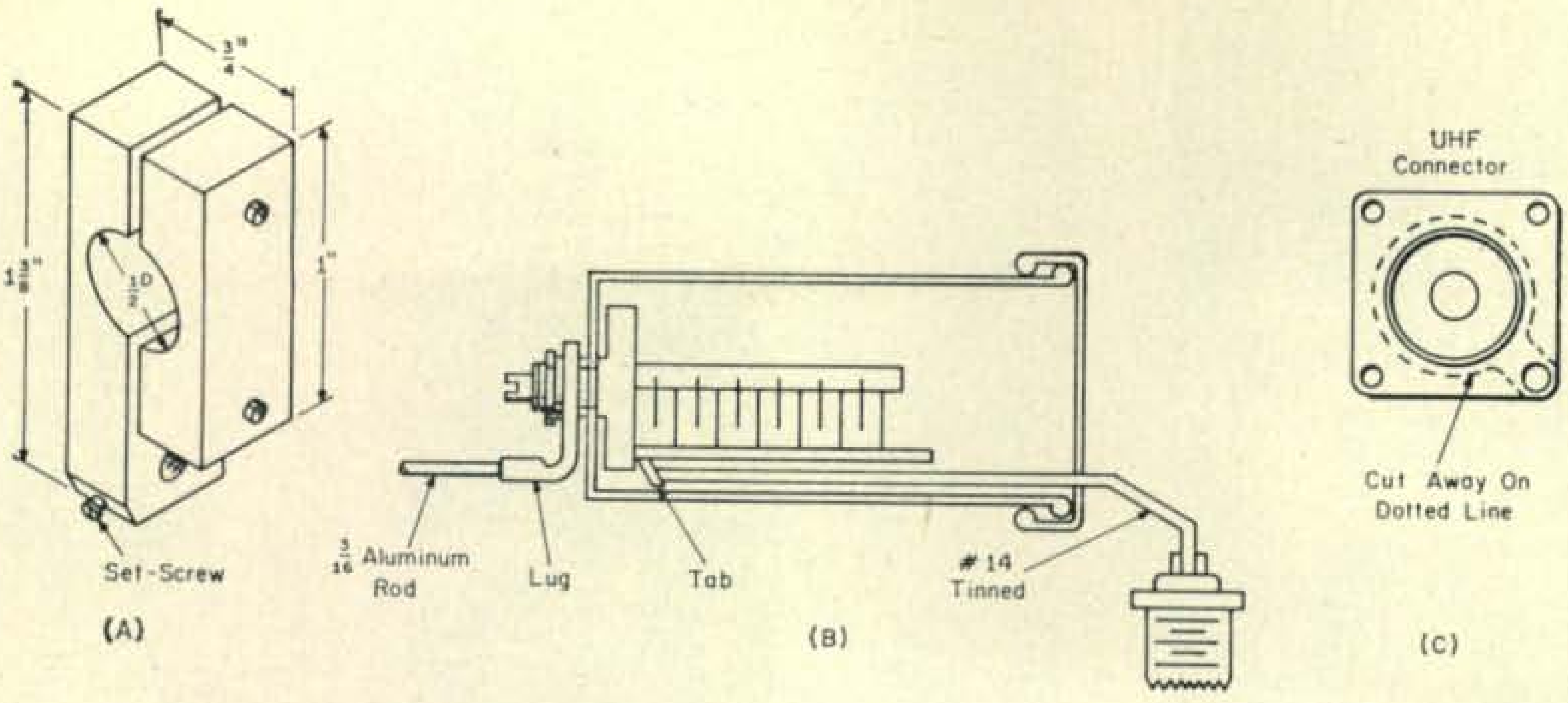


Fig. 4—The gamma match construction is shown above. (A) clamps on the side of the element as shown in the photos. (B) is the pill box housing for the gamma capacitor and (C) shows how the u.h.f. type connector is cut down. The remaining hole is enlarged for a #8 screw.

Mast Clamp

The mast clamp can be made from either a single piece of aluminum, drilled first and then split, or two separate pieces bolted together with a spacer between them while drilling the element holes, to insure a tight clamp on the elements. The radius to fit the mast must be made on a milling machine. This, to me, was the most difficult part of the job except possibly for the brazing of the elements. I would prescribe the use of a stronger mast than is normally used with halos, because this antenna is somewhat heavier. I used a stainless steel mast rather than a larger diameter aluminum job, thereby enabling the retention of the conventional size mast. This provides interchangeability with the halo. The decision of the mast diameter should preceed the milling operation of the mast clamp.

Gamma Match

For the gamma capacitor, a 30 mmf variable is used. A Johnson 30M8 or a Hammarlund MAC-30 is mounted in a pill box or capsule container of the kind you receive with prescriptions. A lug with a 1/4 inch hole for the capacitor shaft mounting, is crimped to a 3/16 diameter aluminum rod, which is used for the gamma arm. A piece of #14 tinned copper wire is soldered to the stator of the capacitor and fed through a hole in the pill box cap. Keeping this lead as short as possible, for mechanical strength, it is then soldered to the modified u.h.f. connector.

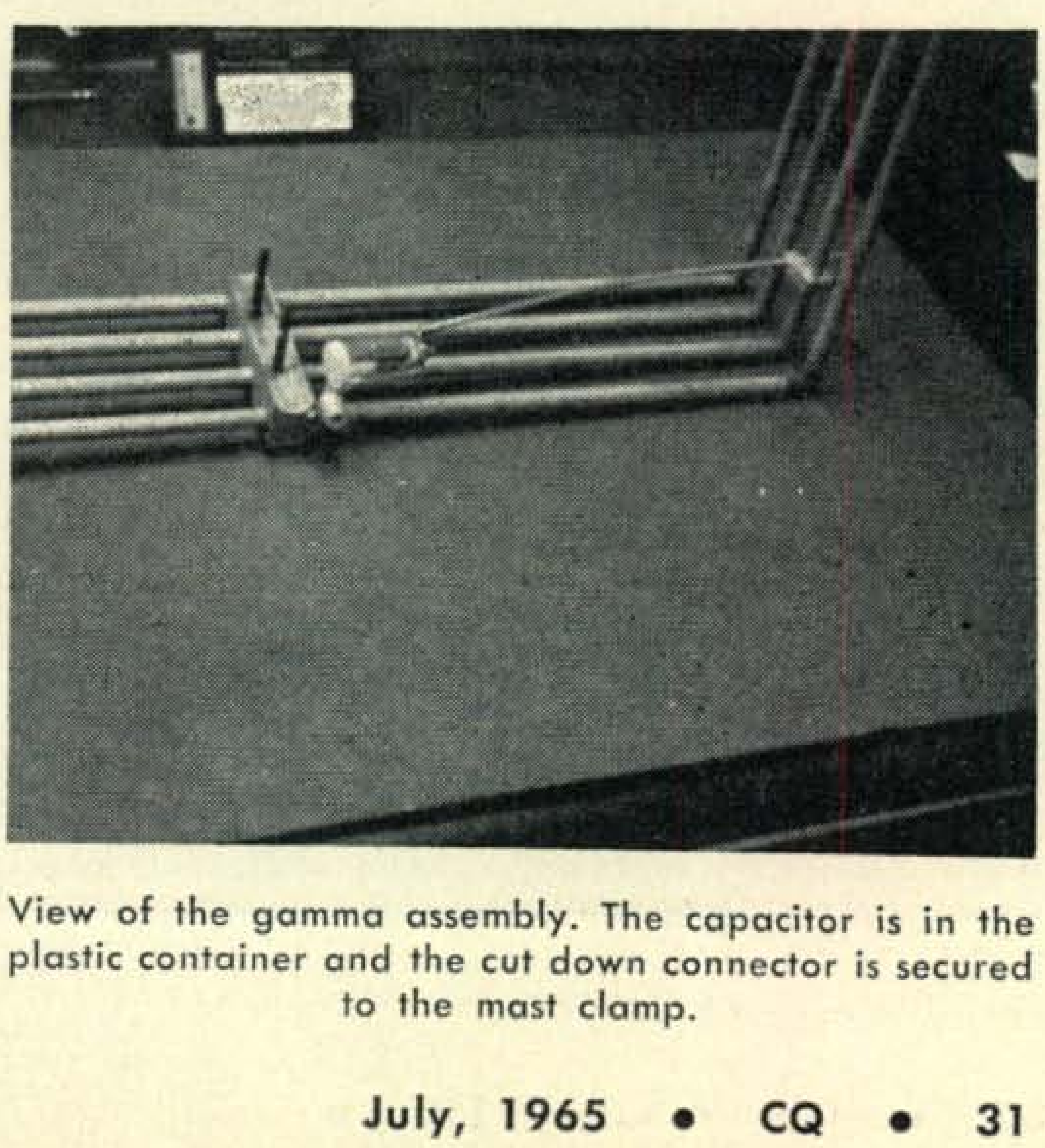
The gamma arm is connected, with the clamp, to one of the elements. Which element is loaded makes little difference. The point of match for the 52 ohm input, is on the side of the element about 2½ inches from the back of the antenna.

Adjustment

Adjustment of the Four Square Six is quite simple. The resonant frequency of the antenna can be checked by picking up the frequency of a grid dip meter on the receiver after dipping near one of the corners of the antenna. If the size of the antenna should vary and the resonant frequency be off, it can be shifted by changing the three inch space at the center. Bringing the plates closer together lowers the frequency. If the antenna measures 28 inches on the center line, this step will not be necessary.

The gamma arm is now installed as previously described. With the transmitter at the center of the desired range, the gamma capacitor is adjusted for minimum s.w.r. The clamp is then moved about 1/8 inch either way. The gamma capacitor is readjusted for minimum s.w.r. If this s.w.r. reading is lower than the previous minimum, you have gone the right way. If it is higher, then move the gamma clamp the other way and repeat the procedure. Keep moving the clamp an eighth of an inch at a time and adjusting the capacitor for minimum s.w.r., until you reach the lowest point, beyond which the s.w.r. would rise.

On the existing antennas this s.w.r. value is approximately 1.05 to 1. This would, of course, vary with the difference between the transmitter frequency and the actual resonant frequency of the antenna itself. These adjustments should be made with the antenna in position on the car and away from any other objects such as cars, trees or buildings. Be sure, also, not to have anyone standing near the antenna while the s.w.r. measurements are being taken. Any object in close proximity will have an effect on the tuning. This is the reason for my belief, that a mobile antenna should be as high and as far away from the car body as possible. I guess that mobile antenna positioning is a compromise between function and beauty, or rather disguise. In any case, where ever the antenna will be permanently, adjust it there and leave it alone. ■



View of the gamma assembly. The capacitor is in the plastic container and the cut down connector is secured to the mast clamp.