generators. The washers should be made out of some type of plastic. The best kind of insulating washer has a shoulder around its hole. You drill a hole in the vehicle body, big enough to allow the shoulder to fit through. This holds the bolt away from the metal body.

If you can't find a plastic washer with a shoulder, it is possible to use two flat plastic washers with a little piece of plastic tubing in place of the shoulder. Make sure the plastic is tough enough to not get cut up by the edge of the hole in the vehicle body.

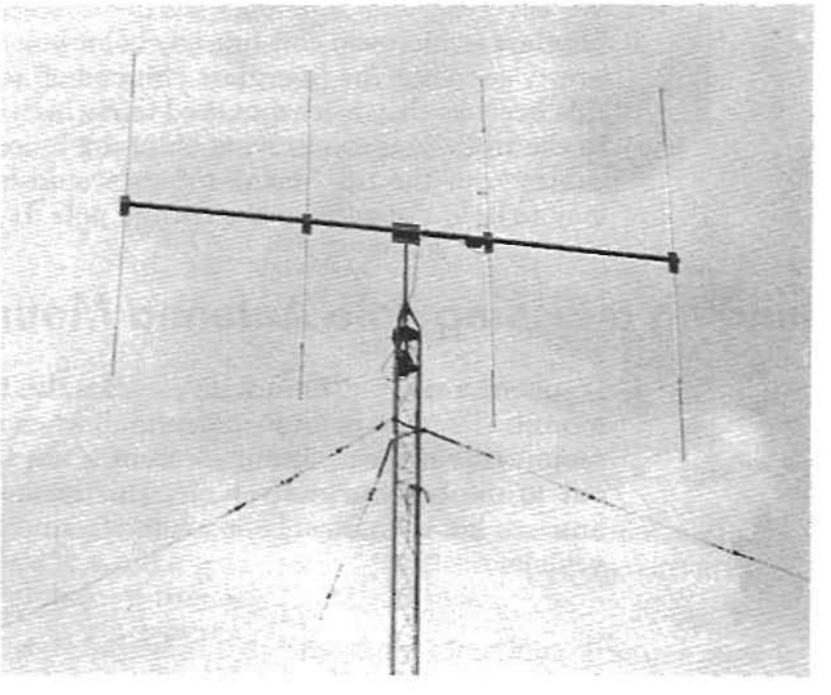


Fig. 11-10
4-element beam

The Long John Antenna
Build a 10 dB gain beam!

A 4-element Long John antenna will make your radio **ten times more powerful** than if you used a ¼-wave vertical antenna. This type of high-gain beam is easy to build. Materials include aluminum plates and tubing, automotive muffler clamps, and radiator hose clamps—all of which are easy enough to find in any large city.

Parts List

4 sections of 1" (2.5 cm) aluminum tubing, 12 feet (3.7 m) long with .035" (1 mm) wall
3 sections of 7.8" (2.2 cm) aluminum tubing, 12 feet (3.7m) long with .035" (1 mm) wall
1 section of 2 ¼" (5.6 cm) OD (outside diameter) aluminum pipe 20 feet (6.1 m) long with a thick wall size
1 section ½" (1.25 cm) aluminum tubing 2 feet (9.6 m) long, any wall thickness
12 2¼" (5.6 cm) muffler clamps with lock washers
8 1" (2.5 cm) radiator hose clamps
2 2" (5 cm) muffler clamps
8 sheet metal screws - No. 8 self tapping
1 plastic box 4" x 8" x 2" (10 x 20 x 5 cm) with sealable lid
4 aluminum plates 4" x 12" x ⅛" (10 x 30 x.3 cm) thick
1 aluminum plate 4" x 10" x ⅛" (10 x 25 x.3 cm) thick
1 aluminum plate 12" x 12" x ⅛" (30 x 30 x .3 cm) thick
1 coax connector–female chassis mount
1 tunable capacitor 0-100 pF-receiver type. (This kind of capacitor can be bought or retrieved out of an old AM radio or other radio junk.)
12 bolts ⅛" (.3 cm) thick x 1" (2.5 cm) long with extra lock washers and nuts
1 plastic knob to fit the capacitor's shaft size
8 U bolts 1" (2.5 cm)
1 piece aluminum sheeting 12" x 12" x 1/32" (30 x 30 x 1 mm) thick
1 small piece of plexiglass 1' x 3' x ⅛" (2.5 x 7.5 .3 cm) thick
1 tube silicone sealer

Tools Needed

Hack saw	metal file
wire cutters	pocket knife
adjustable spanner	tape measure
sheet metal shears	electric drill
screw driver	assorted drill bits

This antenna was designed to have a wide bandwidth so that it could tune from 27.000 to 28.000 MHz with a low SWR. The 6'8" (2 m) spacing between the elements themselves both contribute to the wide bandwidth. It is possible to build a 5-element beam on the same length of boom using closer spacing (as low as 5 feet

or 1.5 m between elements)—but only at the expense of the antenna's bandwidth. Close spacing will also result in less overall gain. In fact, a close-spaced 5 element beam will have no more gain than a wide spaced 4-element one! Close spacing of the elements also makes the antenna tuning adjustment more critical. If the large size of a 4-element beam puts you off, you may want to eliminate the second director element and have a 3-element beam on a shorter boom. But keep the wide spacing between the elements for best overall performance.

Buying The Aluminum

If you can't get the exact wall thickness of tubing that we list, get as close as you can. Make sure that the smaller ⅞" tubing will still fit inside of the larger tubing. If the fit is loose, you may have to make some shims out of sheet metal stock to take up any slack. If you buy your aluminum plates from a sheet metal company, you can often get them to cut the pieces to the exact size you need. We recommend this over having to cut all the pieces out yourself by hand.

It is possible to use a slightly smaller or larger diameter pipe for the supporting boom. But if you switch to another size, you'll also need to change the size of all muffler clamps that attach to the boom.

Assembly of the Beam Antenna

Drilling the aluminum plates. Use a drill bit big enough to allow the muffler clamps to comfortably slide through the holes. The 4" x 12" plate will be used to mount the elements to the boom, and the 12" x 12" plate is for mounting the beam to a supporting pole or mast.

Making the elements. Slice a notch about 4 inches into the ends of each 1" aluminum tube. Make sure that the notch is centered in the middle of the tubing for its full length. File away any aluminum burrs that occur around the notch.

Next, cut the ⅞" tubing into two short pieces for each element. These are the tips of the elements and their length will differ depending on whether they are for the reflector, driven or director elements. Here are their dimensions:

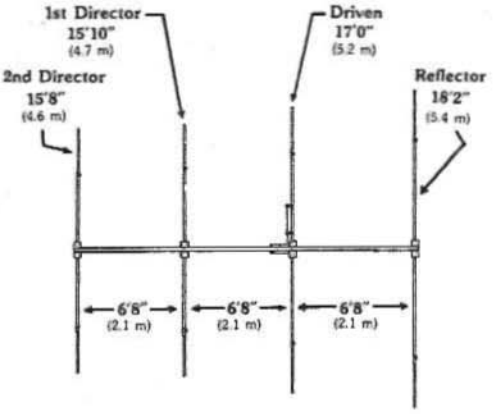


Fig. 11-11 Diagram of a 4-element beam

2 pieces - 4 feet long (1.2 m) - reflector tips
2 pieces - 3½ feet long (1.1 m) - driven elements
2 pieces - 3 feet long (.9 m) - first director tips
2 pieces - 2 feet 10" long (.85 m) - second director tips

Put a mark on each tip piece 1 foot from an end. Slip the reflector tips into each end of a 1" tube so that 1 foot of the tip is inside the larger 1" pipe and the rest extends outside of it. Repeat this procedure when assembling the directors and driven element.

Slip a hose clamp over each junction of 1" to ⅞" pipe. Place the clamp over the 4" slit and tighten until the two sections of pipe are firmly held together. Drill a hole slightly smaller than the size of a No. 8 self-tapping screw about 8 inches back from each end of the 1" pipe. Putting sheet metal screws in helps to anchor the tips to the 1" center sections of the elements.

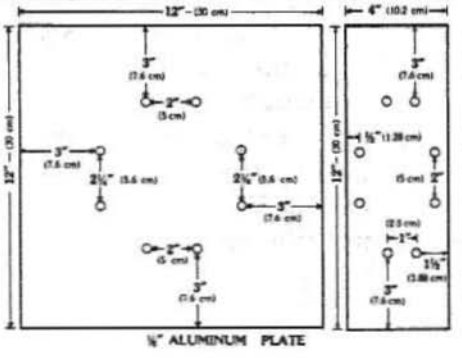


Fig. 11-12 Aluminum mounting plate dimensions

Mounting the elements to the boom. Center each element on one of the 4" x 12" plates. Put the 1" U bolts on and tighten them into place so that the tubing is securely held, but not dented or crimped.

Mark off the 20-foot boom into 6' 8" lengths. Center the plate mounted elements on each of these marks with the reflector first, the driver second, and then the first and second directors. Bolt them in place with the 2" muffler clamps. Make sure that the elements all line up together.

Fig. 11-13 Aluminum tubing dimensions

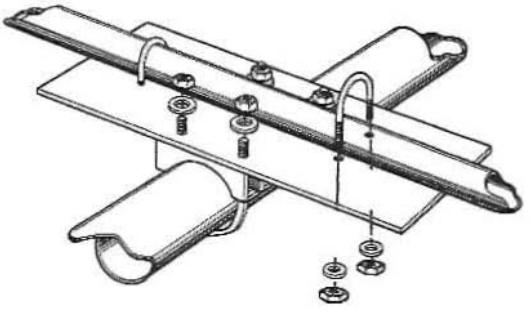


Fig. 11-14 Tubing to boom mount

Feeding the Antenna - The Gamma Match

A beam antenna like the one we are making is fussy about how the radio's power is delivered to it. The antenna must be fed through a balancing device which matches the antenna to the output of the radio and coax. Without the addition of the gamma match, the antenna would have a high SWR and much of the radio's power would be reflected away from the antenna back into the coax. With a gamma match, the antenna can be tuned for a low SWR and the maximum transfer of power from the radio on out to the antenna takes place.

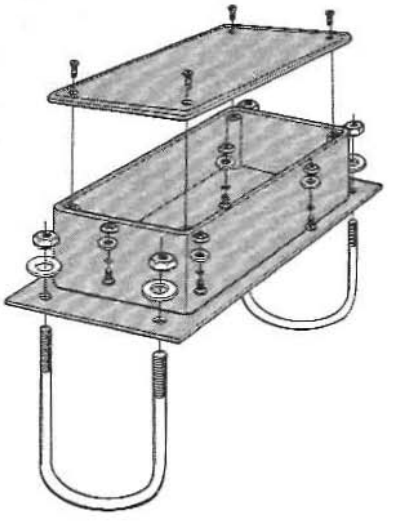
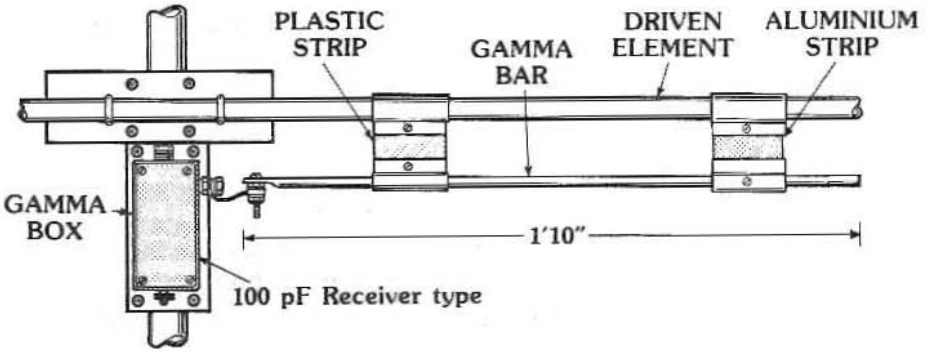


Fig. 11-15 Gamma box

Making the gamma match. The match connects a tunable capacitor in line between the coaxial cable and the driver. This capacitor is mounted inside a watertight plastic container to protect it from the weather. Something like a sealable plastic sandwich box could even work. The coax connector mounts on one end of the box and let's you plug the cable in. A bolt mounted through one side of the box connects to the driven element through a short section of ½" tubing, called the gamma rod. There is a short jumper wire between the bolt and the gamma rod.

Fig. 11-16 Gamma match dimensions



Mount the female coax connector by drilling a good sized hole centered in one end of the plastic box. Carefully widen this hole with your pocket knife until the round part of the connector will fit snugly in place. Mark the four holes that go through the connector and drill them out. Use small bolts to secure this connector to the side of the box.

In the other end of the box drill a hole just big enough to allow the capacitor's tuning shaft to snugly fit through. Mark onto the plastic box where the capacitor's mounting holes should go, and drill them out. Bolt the capacitor in place.

Center the 4" x 8" plastic box on top of the 4" x 10" aluminum plate. Mark the areas on either end that extends beyond the box. Within that extra space drill holes for mounting a 2 ¼" muffler clamp on each end of the plate. Take the plastic box and drill an ⅛" hole in each corner. Center the box again onto the plate and mark the holes onto it. Drill them out and mount the box onto the plate.

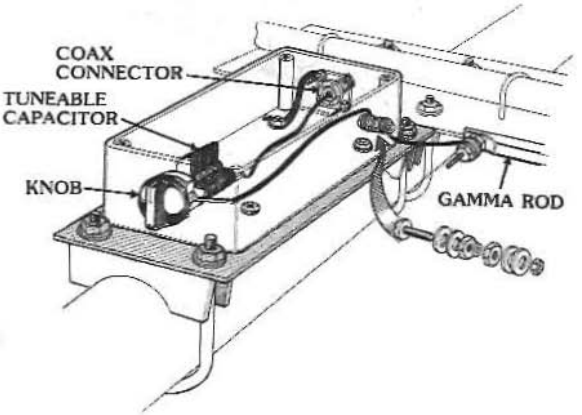


Fig. 11-17 Gamma box connections

Drill a hole in one side of the box and connect a bolt to it. Add on the nuts and washers in the order pictured.

The tunable capacitor consists of two sets of metal plates that can be meshed together by turning the shaft. Solder a wire to the inner conductor of the coax connector.

Attach the other end of the wire to the mounting terminal on the back of the capacitor that connects to the movable plates attached to the capacitor's shaft. Connect the other end of this wire to the bolt that goes through the side of the plastic box.

Take a short piece of copper wire and use it as a jumper between the coax connector's metal base and the closest bolt that fastens the coax onto the aluminum plate. Make sure that this jumper is well secured and that it cannot short out to the inner conductor wire that goes from the connector to the capacitor.

Apply some silicone sealer around the rim of the top and anywhere else where you might think that water could get in. Fasten the lid onto the box. Position the gamma box on top of the boom right next to the driven element, and bolt it in place with a couple of muffler clamps.

The Gamma Rod. Take the section of ½" aluminum tubing and flatten one of the ends. Drill a hole in the flattened end and put a bolt through with a nut and washers.

There are two clamps which fasten the gamma rod to the driven element. The all-metal clamp is made by bending a 2" x 8" strip of aluminum sheeting around the two tubes leaving a spacing of about 3" between them. The second clamp is made out of two short pieces of aluminum with a plexiglass insulator in between the tubes. Unlike the first clamp which is the electrical connection between the rod and the driven element, this second clamp is merely there to give added physical support to the gamma rod.

Run a short jumper wire between the bolt protruding from the gamma box and the bolt on the end of the gamma rod.

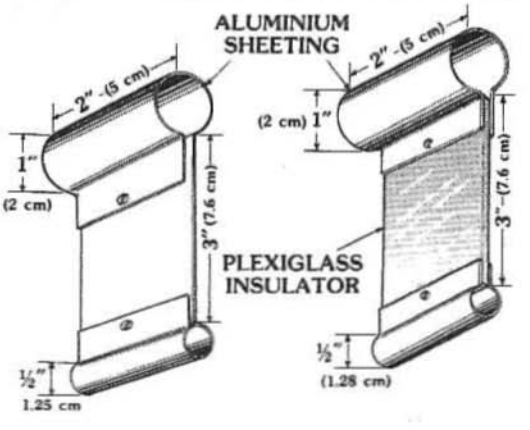


Fig. 11-18 Plexiglass insulator dimensions

Tuning the Gamma Match. In order to do this, you'll need the help of a friend or two. Tilt the antenna back on its reflector and point it straight up in the air. Make sure that no stress is put on the reflector element itself, but on the boom pipe and element plate only. Hook a SWR meter up to the gamma box with a short coaxial jumper. Hook the coax in to the other end. Have someone key up the CB on channel 20 which is in the middle of the CB Band. Don't worry, the two watts or so that your radio puts out will not hurt you. Calibrate the meter in the forward position and put it into the reflected position and take a SWR reading. Adjust the gamma capacitor for the lowest SWR reading. If you can't get the SWR below 1.5 to 1, stop transmitting and adjust the metal clamp that connects the gamma rod to the boom. Move it toward the far end of the gamma rod and take another SWR reading. If the SWR goes down, then readjust the gamma capacitor for the lowest reading. If you still don't have below 1.5 to 1, move the clamp a little further down the rod, until you can get a low SWR. If the SWR went up when you moved the clamp, you may have to reverse directions and move closer to the boom. By adjusting the capacitor and varying the location of the metal clamp connecting between the gamma rod and driven element, you should be able to get a SWR below 1.5. You may have to fine tune your SWR once it is in the air but it should be pretty close to what it was on the ground. Once you have the beam all tuned up and hoisted up there, give someone a shout. We're sure that you'll be getting out!

The Quad
Build This 12 dB Gain Beam!

How about hoisting this one up the flagpole? It definitely looks like she'll fly. It is built out of two or more loops of wire that are supported by fiberglass rods, bamboo or PVC pipe.

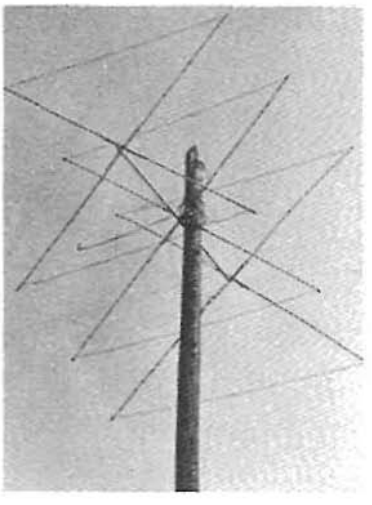


Fig. 11-19 Quad antenna