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A DX Vertical

Here's a simple, effective antenna you can put up in almost no space.

The situation was about as impossible as one could imagine. The rig was a home-brew 100 watt cw transmitter with no drive above 20 meters, the receiver a none too stable 20 year old model, the back yard was full of power and telephone lines, the roof was fragile, slick slate, the rig was on the second floor, the line noise was often greater than S9, and I wanted to work DX! To make matters worse, the budget wouldn't allow more than about five dollars for an antenna, and being a student didn't leave much time for scrounging.

An important consideration was that of size, together with selection of the band or bands to be worked. Listening on a 67 foot wire that ran to a 25 foot high tree in the back yard revealed that the only two reasonable candidates for DX were 20 and 40 meters because of the sunspot situation. This wire had been used in an end-fed manner with a little DX success on 40 meters, but the competition from 40 meter beams and foreign broadcast stations made things pretty tough. The situation on 20 meters was about the same; it worked well for domestic contacts, but fell pretty flat when I tried to work DX.

In order to get the best DX coverage, it is necessary to put as much of the transmitter power as possible into the lowest radiation angle possible. This is so because most of the reduction in signal strength that takes place on an ionospherically reflected wave takes place where the wave passes through the lower layers of the ionosphere. The lower the radiation angle of the antenna, the fewer hops it takes to go between your QTH and those juicy DX locations. Also important is the fact that waves which take off at high radiation angles frequently pass through the ionosphere and are lost. This, of course, is just wasted power.

A study of the vertical radiation patterns for various horizontal antennas which appear in the first part of the ARRL Antenna Book reveals that it is necessary to get a horizontal dipole a half-wavelength or more high in order that the radiation angle be reasonably low. It is also important to notice that even if the antenna is fairly high, there is usually a good deal of radiation in power-wasting high-angle lobes. A fairly good compromise is a height of five-eighths wavelength. This gives a radiation maximum at about 25 degrees above the horizon, with something like 25 per cent of the power going into high-angle radiation. For 20 meters, this height comes out to something like 40 feet, and since there was nothing this high to attach to, a horizontal dipole seemed not too promising.

The vertical radiation patterns shown for a vertical dipole, on the other hand, are much more promising. In particular, the pattern for a vertical dipole with its center one quarter-wave above the ground (this means the lower end of the dipole is right next to the ground) shows a radiation pattern maximum at lower than ten degrees elevation angle when the antenna is located over average, not perfect, ground. There is also no loss of power at high angles because there are no extra lobes. This seemed to be the answer for working DX within the limitations of my QTH. A vertical dipole for 40 meters would be 70 feet high, a pretty tall order for the $5.00 budget and also for the limited space available for the guys which would be required for a mast of this height. For 20 meters, the height came out to be 33 feet 2 inches for the CW band, a height which could be supported by the house alone.

The antenna was mounted as shown in Fig. 1. The support points are the bottom of the mast and a point about two-thirds up the mast. This has proved adequate in winds up to 50

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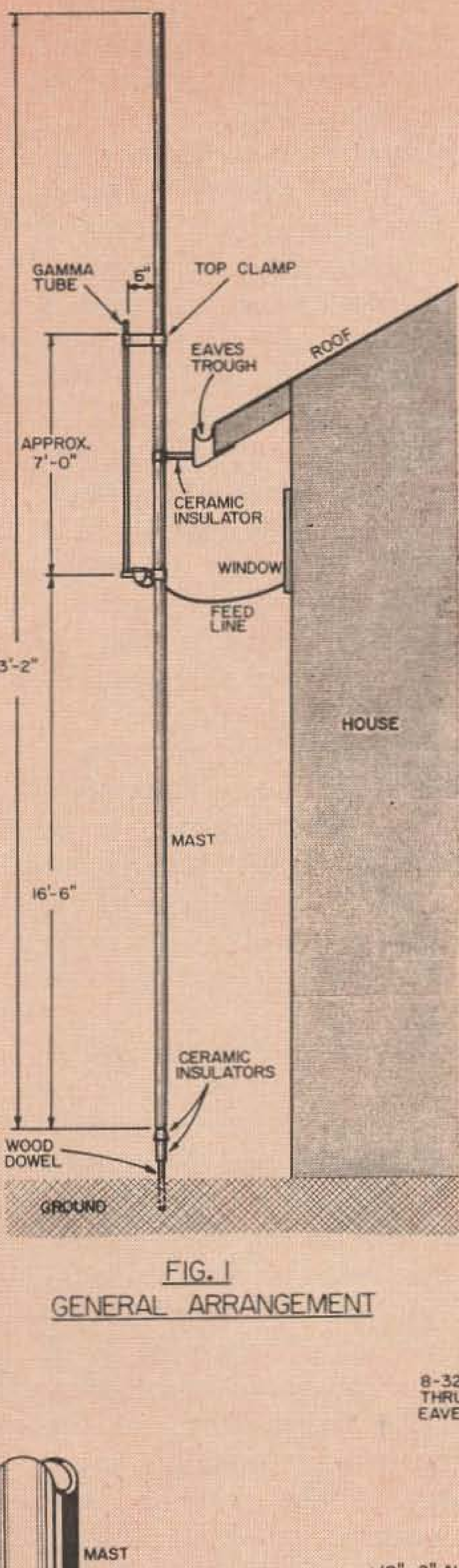

FIG. 1
GENERAL ARRANGEMENT

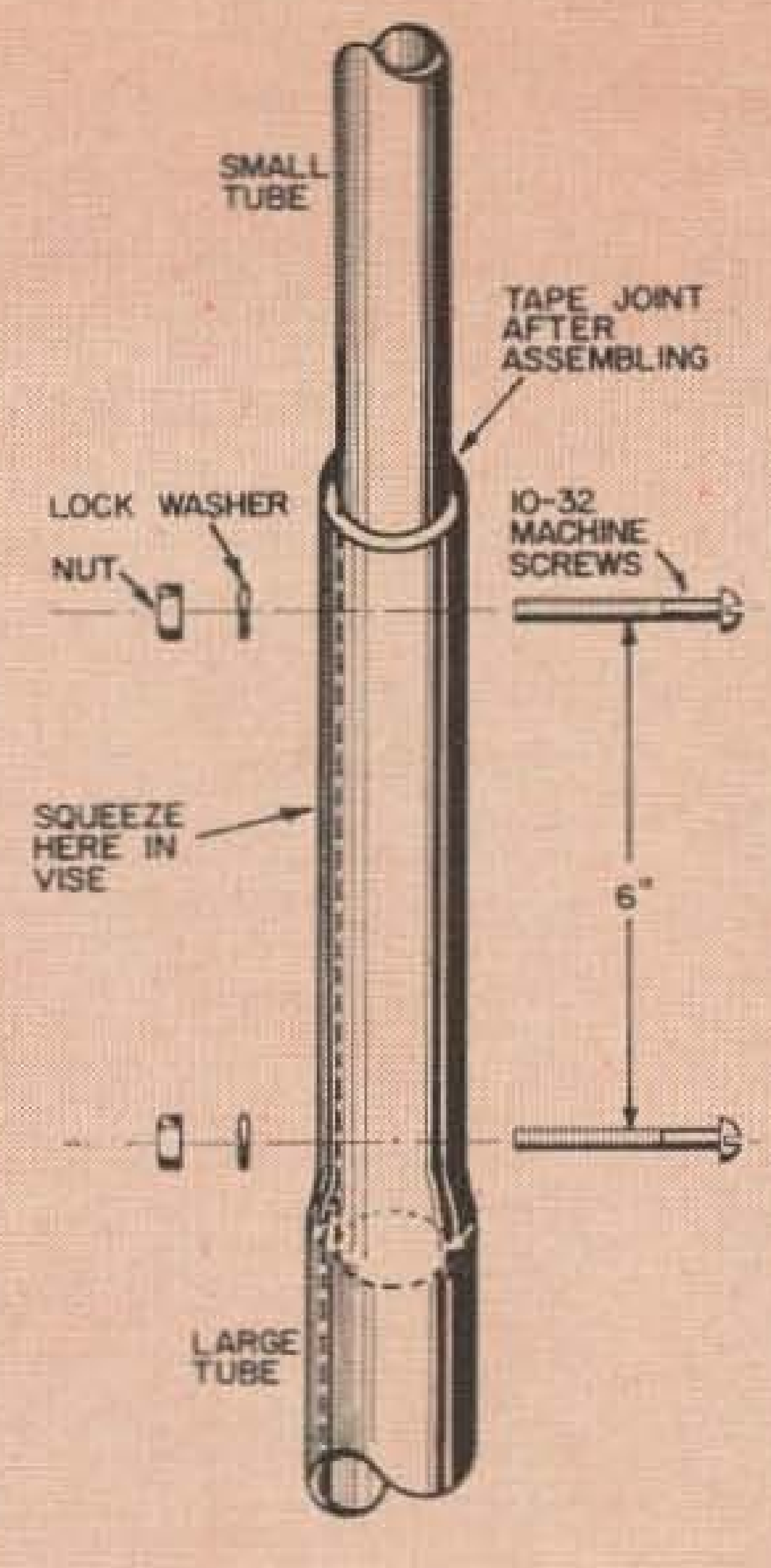

FIG. 2
MAST JOINT DETAIL

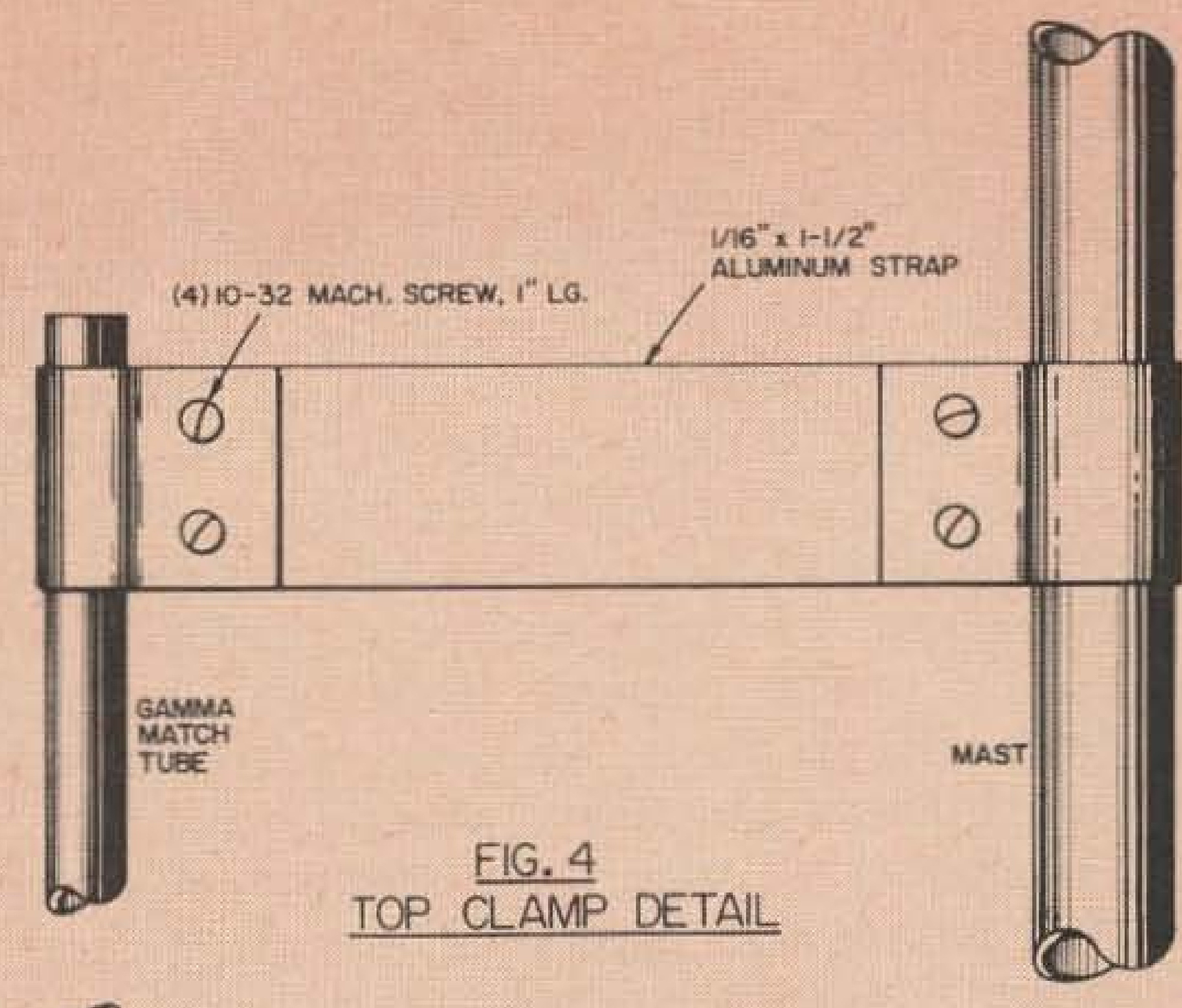

FIG. 4
TOP CLAMP DETAIL

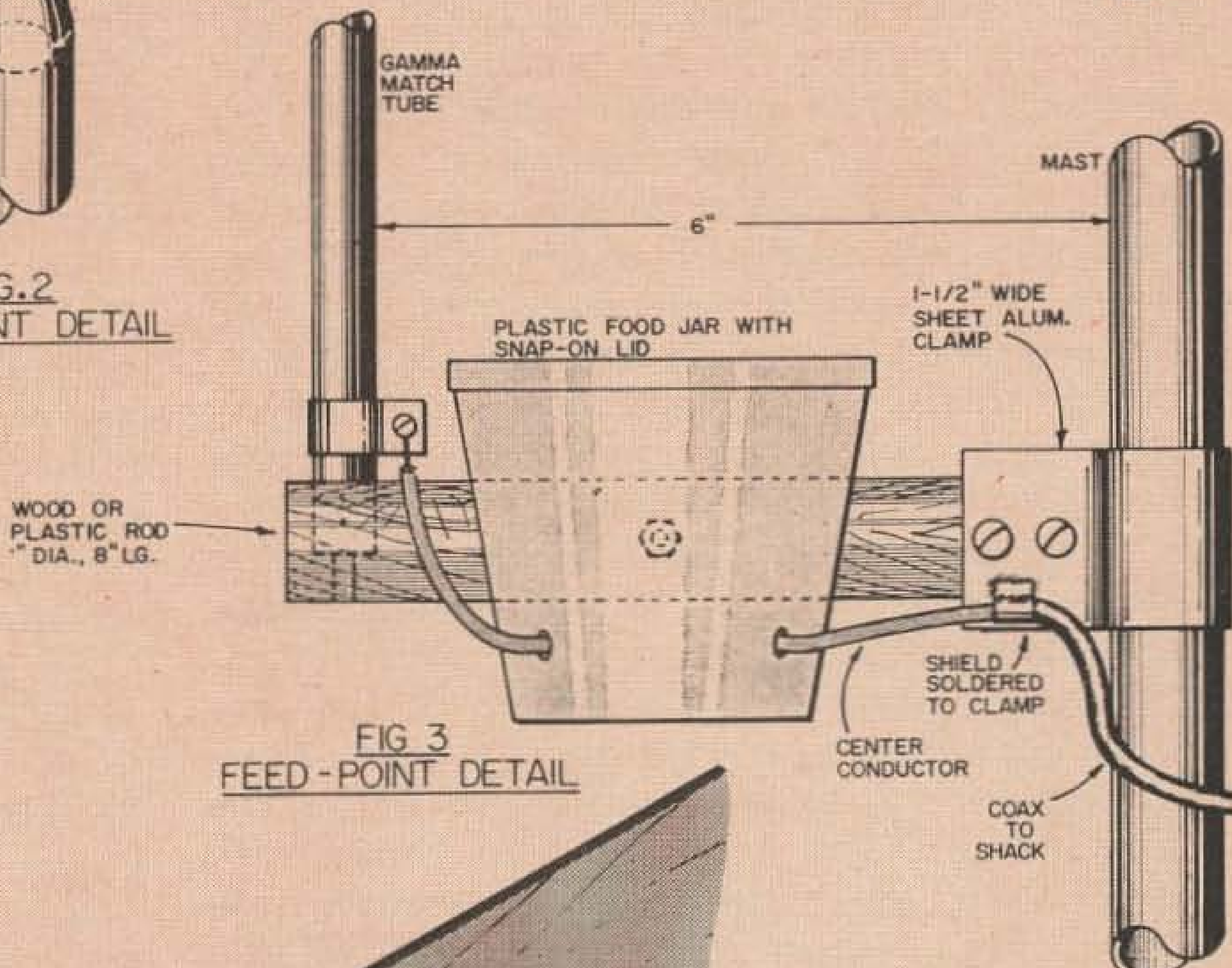

FIG 3
FEED-POINT DETAIL

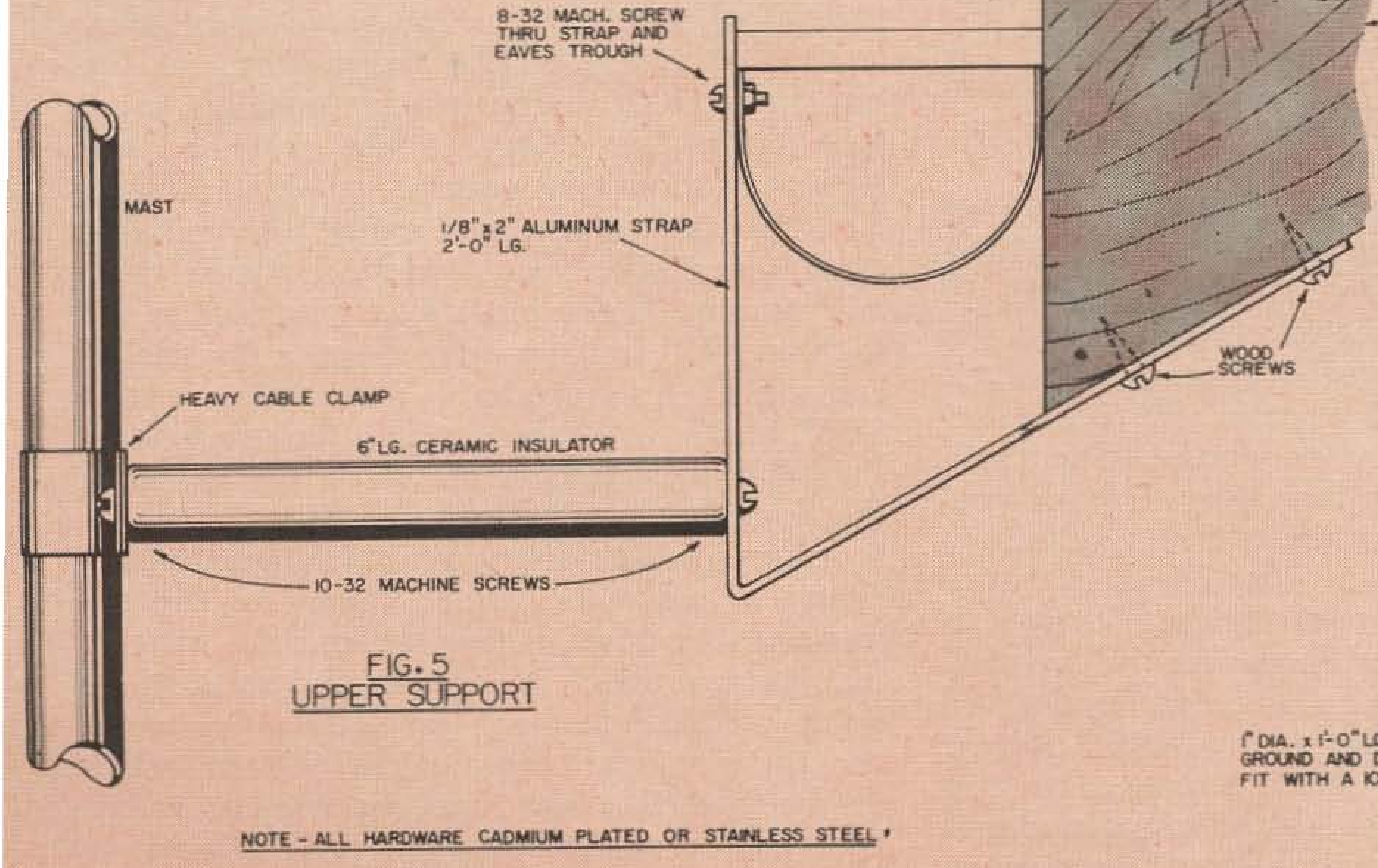

FIG. 5
UPPER SUPPORT

FIG. 6
BASE SUPPORT

1" DIA. x 1'-0" LG. WOOD DOWEL DRIVEN INTO GROUND AND DRILLED TO MAKE A TIGHT FIT WITH A 10-32 MACHINE SCREW

NOTE - ALL HARDWARE CADMIUM PLATED OR STAINLESS STEEL or 60 miles per hour, the highest usually encountered in this location. Since the dipole is a full half-wavelength long, it is conventional to feed it at the center. This turned out to be a rather convenient point in this case, as it fell near the height of a window in the second-floor shack. I chose to feed it with a gamma match to avoid splitting the mast in the center and to provide an unbalanced coax feedline. It should work equally well as a vertical doublet.

The antenna mast itself was assembled from various pieces of scrap aluminum tubing which were purchased during one morning's scrounging. If nice, long sections of telescoping tubing are available, by all means use them; I wasn't so lucky, but I still got the thing put together. In my particular one, the bottom 10 feet is a piece of one inch aluminum conduit, the center section is a two section thinwall aluminum TV mast about 13 feet long, the next section is a discarded TV antenna boom with the elements removed, and the remainder of the 33 foot 2 inch length is made up of two pieces of aluminum tubing scrap. This length was found from the equation $L = 468/f(MHz)$ where L is in feet.

Since the tubing didn't telescope together nicely, it was necessary to devise some means of fastening them together. This was accomplished by squeezing the larger of the two tubes for a particular joint in a vise until it was narrow enough to provide a tight fit for the smaller tube. The joint was then bolted with two bolts about six inches apart through both tubes. **Fig. 2** illustrates the method. All the joints were taped with plastic electrical tape after they were assembled to keep moisture out. Cadmium plated hardware was used everywhere to prevent corrosion and rust. Stainless steel hardware would be even better, but I have seen no signs of rust after two years with the hardware I used.

Fig. 3 shows the details of the gamma feed arrangement. The gamma tube is fed from the center conductor of the coax through a 33 pF variable capacitor which is enclosed in a plastic refrigerator jar to protect it from the weather. It is important to drill a small hole in the bottom of the jar to allow condensation to drain out. I learned this the hard way. I didn't provide a hole, and after about 6 months of operation there was about a half inch of water standing in the bottom of the jar. Changes in barometric pressure cause the jar to "breathe" humidity inside. The top of the jar is removed to adjust the capacitor during initial tuning. Once it is tuned, the lid is snapped back in place. The jar attached to the wooden dowel with a long 6-32 screw which passes through the dowel, through the jar, and screws into one of the mounting holes of the variable capacitor. This joint was sealed with mastic cement between the jar and the dowel to prevent rain from entering the jar at this point.

The gamma tube is supported on the bottom by being set into a hole drilled partway through the dowel. This should be of such a size to provide a snug fit for the tube. A small hole, concentric with the large one, was drilled entirely through the dowel to allow rain to pass freely through the gamma tube and out the bottom. The electrical connection is made at the bottom of the tube by means of a clamp made from scrap sheet aluminum and fastened with a 6-32 machine screw which also holds the solder lug for the wire from the capacitor. This joint was taped after completion of the antenna. The top clamp is shown in **Fig. 4**, and consists merely of a piece of sheet aluminum formed into clamps at both ends.

Fig. 5 and **6** show the details of mounting. The long ceramic insulators shown happened to be on hand; probably something smaller in size would be adequate. The mast turned out to be only about three feet from the wall of the house. A larger spacing would be desirable from the standpoint of efficiency, but the property line prevented it.

Adjustment of the gamma match proceeded as follows. The transmitter frequency was set to the center of the desired frequency range (in my case it was 14050 kHz) and the output power was adjusted for the minimum required to give full-scale deflection on the SWR meter. (An SWR meter or impedance bridge[1] is essential for the proper tuning of any antenna system.) If possible, choose a time when the band is dead so as to cause a minimum of interference. Before keying the transmitter, set the top gamma tube clamp to some position, say 6 feet above the center of the antenna, and tighten it. (now take your hands off the thing!) Key the transmitter and adjust the variable capacitor until the standing wave ratio is minimum. If the reading at minimum is too high, move the clamp up or down a few inches and repeat the procedure. If this improves the SWR, move the clamp again in the same direction. If the SWR goes up, move the clamp in the opposite direction. If the SWR cannot be brought to a satisfactory level, it might be necessary to move the center clamp on the antenna up or down a few inches. The part of the antenna which is close to the wall of the house will be somewhat detuned by the house, and the electrical center of the antenna might not be located at the exact mechanical center. It should be possible to get the SWR down to

1. Kyle, Jim, "R.F. Measurements," 73, Dec. 1965, p. 20.

1 to 1 at the center frequency; I quit when I hit 1.25 to 1. It stays below 1.75 to 1 anywhere in the CW band, which is entirely satisfactory for all but the most touchy transmitter pi-network.

The tuning was accomplished by having one man on an extension ladder and the other at the rig. Since the total feed line length for my installation was only seven feet, and the window it passed through was left open during the tuning procedure, there was no problem of communication between the man at the rig and the man on the ladder.

A convenient feature of this antenna is the ease with which it may be lowered for inspection and repair. It is necessary only to remove one screw from the upper insulator, disconnect the feed line from the transmitter, tie a strong cord to it above the center, and lower away. I am able to do this from inside the shack by opening the upper half of the window. To raise it, it is necessary to have someone position the bottom of the mast over the bottom cone insulator and hold it there while I raise it back to a vertical position. The XYL performs this task admirably.

A note about radials. One of the reasons for selecting this type antenna is that it is center fed and does not require radials for efficient operation. The more popular vertical is a quarter-wave type which must be fed against a radial system or some other form of ground. The reason that many of these fail to live up to their expectations is because of an inadequate counterpoise. A single ground rod at the base of a quarter-wave antenna is usually not adequate. I know; I've tried it with disastrous results! The transmitter power is dissipated in large ground resistance which results from a poor ground. A good system of buried radials is excellent for a quarter-wave vertical, and a system of radials above ground for the popular ground plane antenna works well. I did not have room near or in the ground, and the fragile roof and a landlord who discouraged me from walking on it prevented the erection of anything on the roof.

I did try stringing some radials in the basement and feeding the whole mast against these for 40 meter operation using a variation of the bazooka balun feed, but that's another story.

On the air results have been very encouraging in the relatively little operating time I've had available. A check in the log shows mostly 569 and 579 reports out of Europe and 589's out of Central and South America. Since I am restricted to Saturday morning operation, I don't usually hear the Asian and Pacific stations.

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