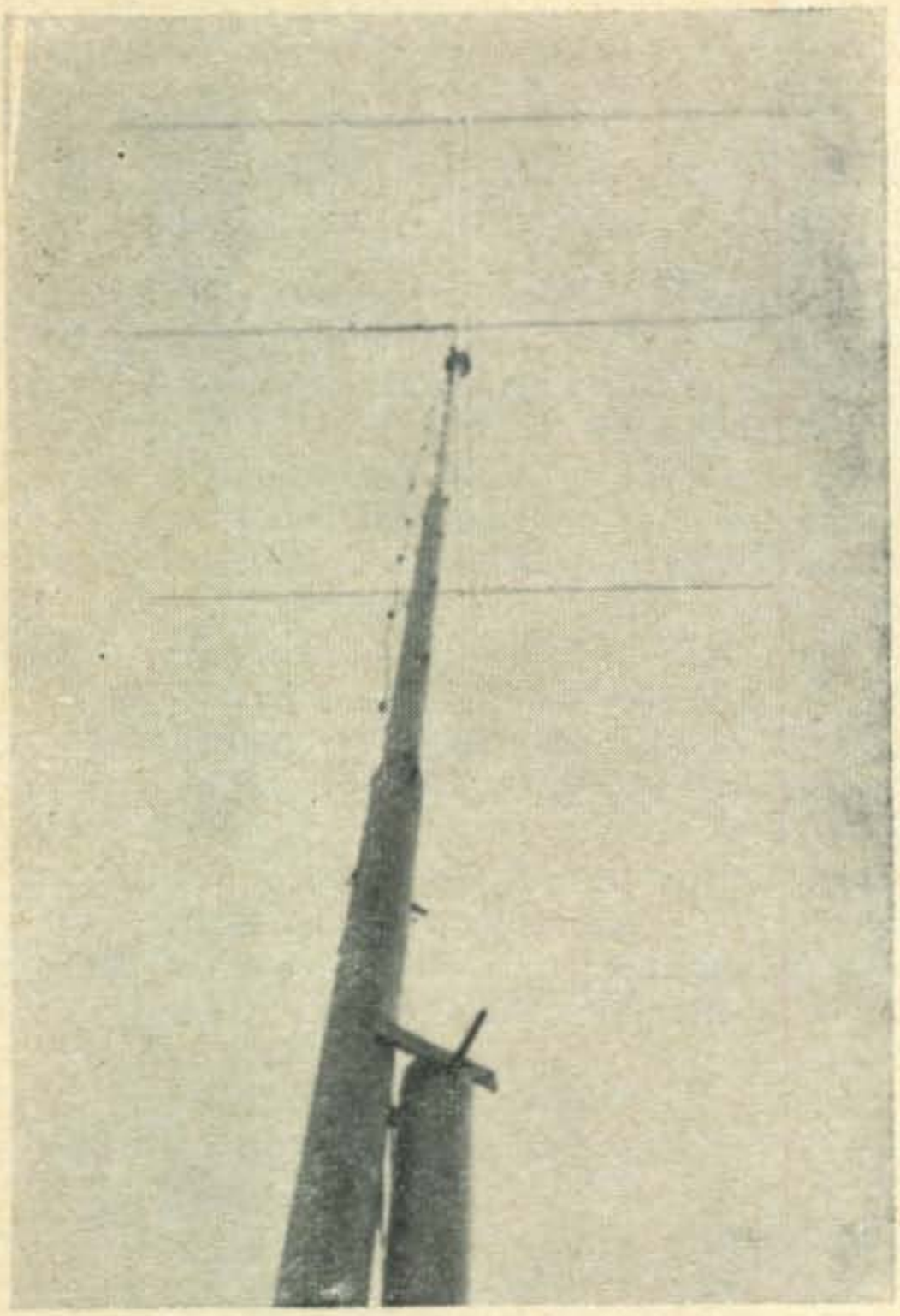

A Self Supporting Antenna Mast

BY R. P. HAVILAND*, K3BGX

This self supporting tilt-over mast, made from standard pipe length, is 65 feet high and can support 50 pounds of antenna and rotor.

THE mast described here offers a desirable combination of all the features that are usually needed for amateur antenna support. It is self supporting and so eliminates the need for an extensive guy system. It is designed to fold over, which is a great convenience during erection and also eliminates the usual problems of getting to the top of the tower for antenna changes. It is made of widely available materials and is designed to support up to 50 pounds of antenna and rotator at a height of 65 feet.

The mast is constructed from 21 foot lengths of standard steel pipe with each succeeding section being two pipe sizes smaller so it will nest inside of the next lower unit. The drawing of fig. 1 shows the general layout and the overall dimensions used. Four lengths of pipe fastened together make up the mast. A separate 21 foot pipe, 4" in diameter serves as the mast support and as a gin pole. Hinge pins fasten the mast to the gin pole and allow for fold over. The gin pole is set into the ground in a 6' section of 6-inch pipe which is set in concrete, and which serves as the foundation.

Figure 2 shows the construction of the joints between pipe sections. Except for bolt size, this is the same for all of the joints. The main vertical load is carried by two bolts which pass through the two pipe sections, one near each end of the joint. These two bolts are at right angles. In line with each bolt, the outer pipe is drilled and tapped for a set screw which is used to adjust the position of the inner pipe along the load-carrying bolt. These set screws eliminate side movement and also serve to compensate for small errors in drilling the pipe. The top end of these joints are wrapped with sheet rubber from an old inner tube, held in place by clamps or wire. This keeps water out of the mast.

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Hinge Construction

The hinge construction is shown in fig. 1 and in the photographs. These hinges are made by welding ¼" steel plates to either side of the bottom mast section to form a U. The outer ends of the U are drilled for a pin made of standard ½" steel rod. Washers and cotterpins are used to hold the rod in place. The lower pin is removed whenever it is desired to fold the mast down, and the upper pin is used as the hinge. (Note: the top of the gin pole section should be sealed with a wood disk to keep out rain.)

Counterbalance

The mast is counterbalanced so that raising or lowering the mast can be done quite easily. Counterbalance is obtained by loading the bottom section of the mast with about 150 pounds of scrap steel. Broken truck axles were used here. This gives nearly perfect counterbalance for the mast alone. With the 50 lbs. of rotator and antenna mounted at the top of the mast, the weight at the bottom is less than required

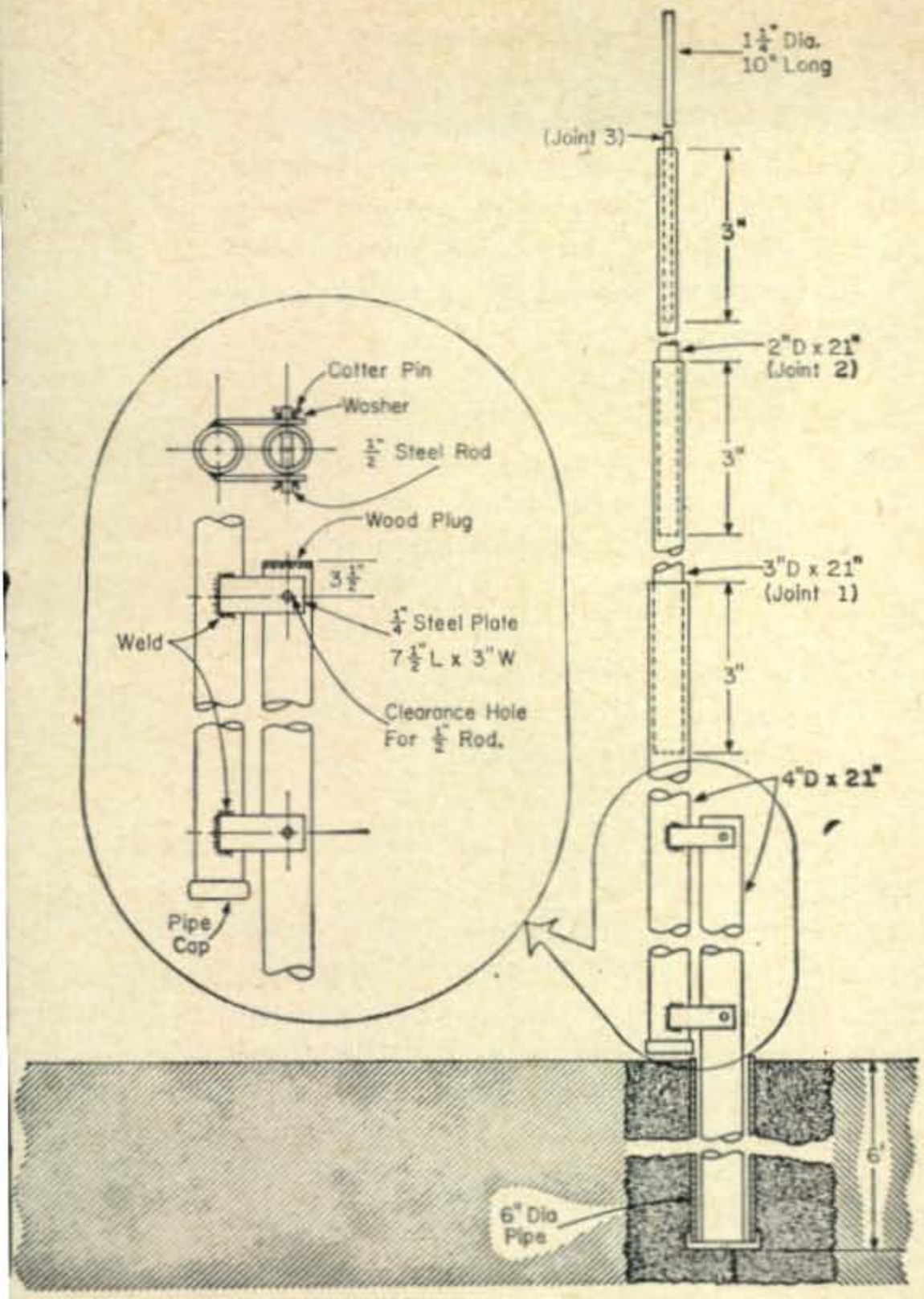

Fig. 1—General layout of the self supporting mast. The 6" diameter pipe is set flush with the ground and, with the concrete mix, provides a foundation suitable for winds up to 75 m.p.h. Details of the hinge construction are shown in the inset. A wooden plug is inserted in the top of the 4" gin pole.

for perfect balance, so a block and tackle must be used to raise or lower the mast as shown in fig. 4.

To eliminate internal rusting, a ¼" hole should be drilled in the center of the 4" pipe cap.

Foundation

At K3BGX, the foundation section of the mast is buried in a shale ledge which starts about a foot below the top of the soil. This is not a normal situation, however, since most masts would be installed in clay or sandy clay. For average soil, the foundation should be a 6 foot section of 6" diameter pipe buried flush with the ground. This should be capped at the lower end with a standard pipe cap, with 2 one-quarter inch holes drilled through it for drainage. The pipe should be centered in a hole 24" square, which is filled to within 6" of the surface with concrete. Scrap iron and large stones may be imbedded in the concrete if available. About 2/3 of a cubic yard of concrete is needed.

The space between the 4" gin pole and the 6" foundation section is filled with sand. This serves two purposes. It holds the mast vertical, and it also serves as a vibration damper to keep the mast from building up a large sway during storms.

Mast Construction

Second-hand pipe is used for the mast, but it should be in good condition. A small amount of rust, scale, etc., at the surface does no harm, but pipe that shows appreciable amount of pitting or corrosion should be rejected. In the mast described, the used pipe came from an oil refinery and both the inside and outside surfaces were in perfect condition. The outside was thoroughly cleaned, then wiped with mineral spirits. Two coats of penetrating aluminum paint (Rustoleum) were applied. A further touch-up coat was given after erection.

There are a number of ways in which the mast may be erected. The one used involves renting four sections of steel scaffolding of the type used by painters. This provided a temporary tower, 20 feet high, which was used for all of the erection operations and for other odd jobs such as touching up the paint and installation of the antenna and rotator leads.

For the actual erection, the scaffold was set up about 6" from the foundation pipe. The gin pole was picked up by block and tackle, and slid into the foundation pipe. The pole was centered in the foundation pipe by small wedges and plumbed to insure that it was vertical. Sand was then poured around the pole and settled by tapping vigorously with a hammer. After the foundation pipe was filled, the wedges were removed. The mast was temporarily separated at the second joint so that only the bottom two sections needed to be raised. The same block and tackle arrangement was used with the attach point to the

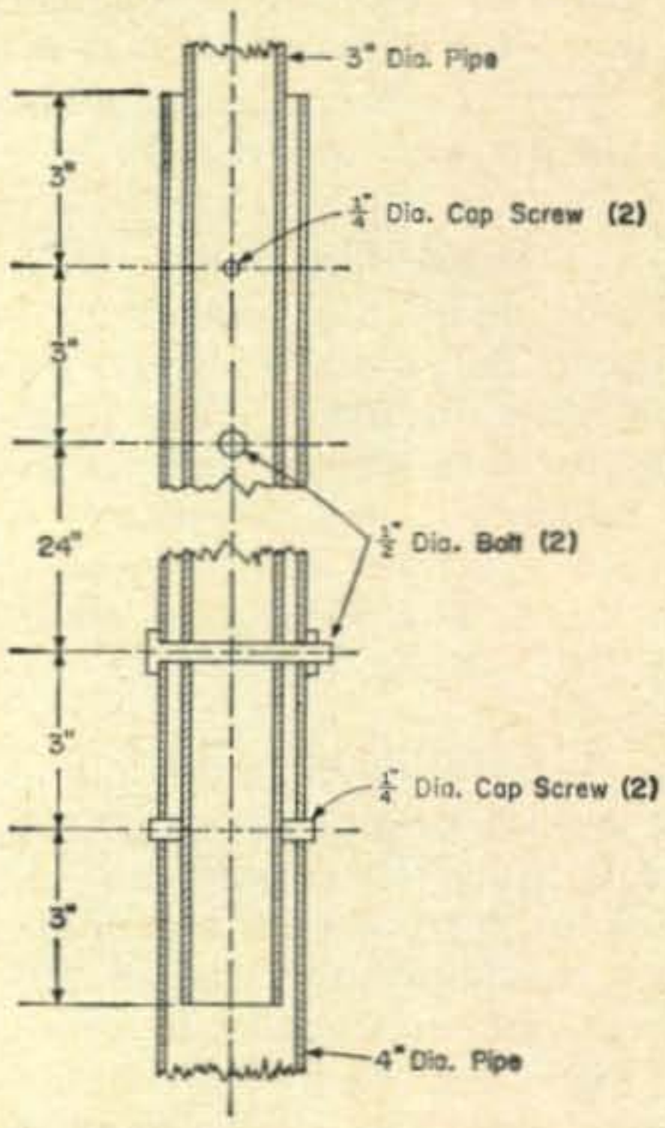

Fig. 2—Details of the joint construction. The joints for coupling the 3" pipe to the 2" length and the 2" to the 1¼" pipe are identical except for reduced diameters and bolt size.

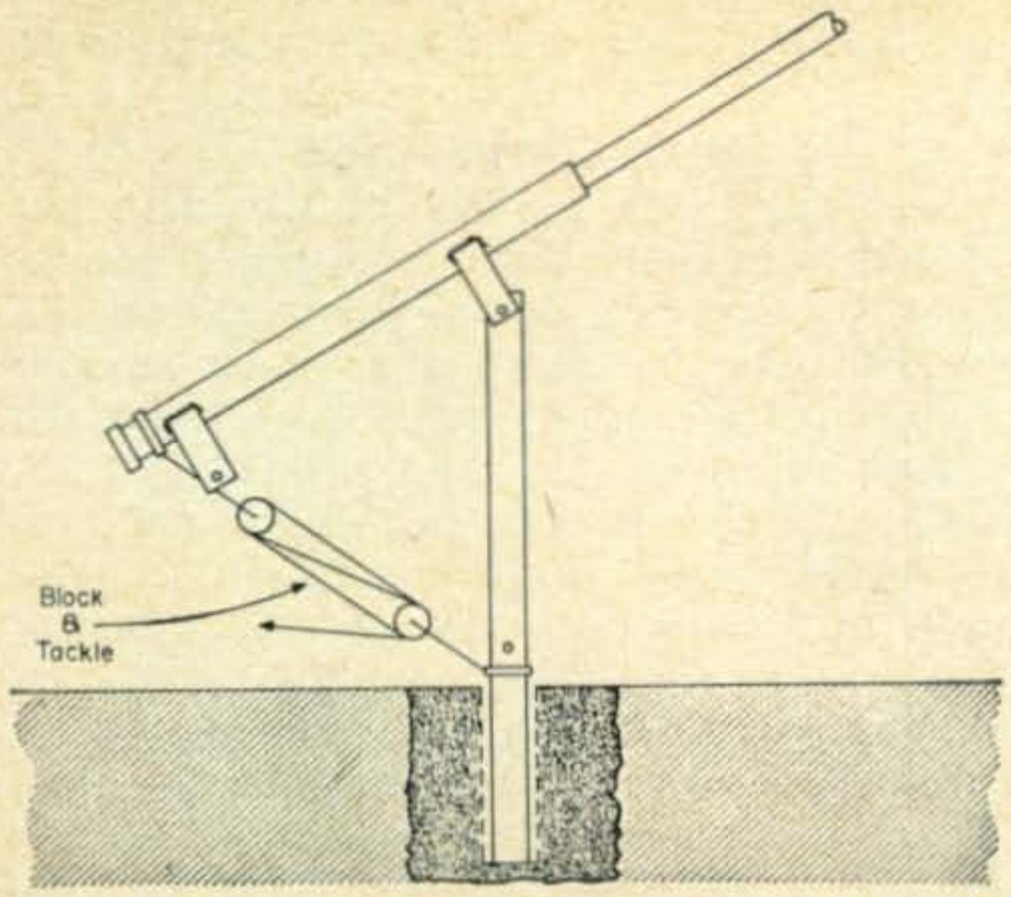

Fig. 3—Set up for the block and tackle to aid in raising and lowering the mast.

mast being just below the top hinge, at the point of balance. The mast was pulled up to the vertical and positioned so that the top hinge pin could be inserted. Thereafter, this pin is not removed. Before erection a pull rope was tied to the upper section, and the tackle block on the lower, as shown in fig. 4.

The scaffolding was then removed and the mast was pulled over by the rope. The upper two sections were then inserted into the lower sections. The attachment bolts were installed and the adjustment screws placed. The scaffold was then used to touch up the paint and to install the antenna leads. Finally, the counter weights were slid into place and the lower pipe cap put on.

An easier method of erection is to use the truck hoist of a company specializing in neon sign work. Most of these have sufficient capacity to lift the completely assembled mast section. Also, with careful rigging it should be possible to do the job with the gin pole alone.

Load Figures

It should be noted that maximum load on the mast occurs when the mast is horizontal, with the antenna in place. This load is less than 20,000 lbs. per square inch, in conformance with building codes. Maximum load on the foundation occurs with the mast vertical, under high wind. The foundation described is satisfactory for winds up to 75 m.p.h. in average soils.

The general construction of this mast is satisfactory for greater heights or larger top loads. However, if it is desired to extend it to heights above 55′ or to carry larger antennas, it will be necessary to change the size of pipe since the loads on the sections will exceed safe values. In this case, each succeeding section should be one pipe size smaller than the next lower section. As can be seen from a table of pipe sizes, these nest easily. It is recommended that any re-design be analyzed carefully for strength and balance. Equations for doing this

List of Materials

1	21′ length 4″ steel pipe, threaded one end
1	21′ length 4″ steel pipe, not threaded
1	21′ length 3″ steel pipe, not threaded
1	21′ length 2″ steel pipe, not threaded
1	10′ length 1¼″ steel pipe, not threaded
1	6′ length 6″ steel pipe, threaded one end
1	6″ pipe cap
1	4″ pipe cap
2	½″ steel rods, 7½″ long
4	½″ bolts, 6″ long, coarse thread
2	¼″ bolts, 4″ long, coarse thread
12	¼″ screws, 1″ long, coarse thread
4	¼″ steel plates, 3″ X 7½″, per drawing
4	½″ washers
4	3/32″ cotter pins
150	lbs. scrap steel (broken truck axles)
2/3	yard ready mix concrete

are given in any standard engineering handbook.

For these higher masts, the foundation becomes increasingly important. Because of the wide variations in local soil condition, no definite rules can be given for the foundation. In average soils, the foundation pipe length should be equal to one-tenth of the height above ground. In case of doubt, it would be well to consult the local power company for their installation method.

In many locations a construction permit will be required for the installation. Before applying for this, the soil at the foundation point should be checked by a test boring, and the type, whether sand, clay, etc., noted. Usually the County Engineer can be consulted for assistance in making these checks and for an opinion as to their adequacy. He will also, of course, have to approve the design before a construction permit can be issued.

General

The cost of the mast will depend on local prices for used pipe, and on the method of erection. The cost of the pipe used, including fabricating the brackets and welding was just over 65 dollars. Small parts, concrete, rental of scaffolding and so on came to about 25 dollars. These costs should be typical.

The mast has been in use for three years. It has been lowered annually for repainting, and check of the antenna rotator. Lowering is easily done by one person, in about 5 minutes. Two or three are needed to raise the mast to vertical, this taking perhaps 10 minutes.

Maximum winds experienced have been gusts to 55 m.p.h. In such winds the antenna moves several feet, but there is no movement of the lower section. The design is calculated to withstand in excess of 75 m.p.h. winds, but if these are forecast, peace of mind indicates that the mast should be lowered.

The general construction of this mast appears to have originated in Oklahoma where it is used for television antennas. ■