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Wind Instrument Mountings for Above-the-Cab Lookout Exposure

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ABSTRACT: The lookout tower offers a ready-made platform from which the speed of true unobstructed wind can be measured, then reduced to equivalent of 20-foot wind. Tower-mounted instruments must meet the requirements of a lightning conductor system, but should also be easily installed and removed for storage and maintenance. Lightweight aluminum mountings for catwalk or flat-roofed installations are described.

RETRIEVAL TERMS: wind velocity measurement; lightning protection; wind speed conversion; wind gages; anemometers; wind instrument exposure.

OXFORD: 111.5--015.7.

Where air flow is obstructed by cover, buildings, or terrain, a meaningful wind measurement can be obtained only from instruments exposed above the obstructions. A lookout tower provides a readymade platform for support of an additional mast. Instruments mounted above-the-cab can sample the unobstructed air stream.

Three types of over-the-cab mountings are described in this note: (a) the catwalk corner-post mounting; (b) the building-corner catwalk mounting; and (c) the flat-roofed-lookout center mounting.

Wherever the resulting instrument height exceeds the standard 20 feet above obstruction, the observed speed may be easily reduced to the equivalent 20-foot wind by a multiplying factor. The multiplying factors for converting wind speed observed at height greater than 20 feet above obstruction to speed at 20 feet above obstructions are as follows:[1]

Height anemometer above obstruction (feet)	*Multiplying factor*
30	0.95
40	.91
50	.88
60	.86
70	.84
80	.82
90	.81
100	.80
125	.78
150	.75
200	.72

For example, a 40 m.p.h. wind observed at an anemometer 60 feet above obstruction would be

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40 x 0.86 or 34.4 m.p.h. at 20 feet above obstruction.

The factors are based on 1/7 power law recommended for strong winds and dry adiabatic conditions. The power law equation is

$$\frac{V_{20}}{V_h} = \left(\frac{20}{h}\right)^{\frac{1}{n}}$$

in which V_{20} = speed at 20 feet above obstruction

V_h = speed at instrument level

h = height of instrument in feet above obstruction

value of $\frac{1}{n}$ has been determined by observation to be 1/7.

Where the location requires a lookout tower, over-the-cab anemometer exposure is more reliable than other alternatives. All mountings below cab level and either near or within the tower have the limitations of partial obstruction by the tower structure itself. This obstruction varies in amount with wind direction. The proper corrections are difficult to determine; hence the completely open exposure above the lookout cab provides the most reliable indication of true wind.

REQUIREMENTS FOR MOUNTING

The mounting of wind instruments on a lookout tower involves meeting certain requirements:

1. The instruments must be away from obstruction or distortion of flow caused by the lookout structure itself. Exposure must be at least 8 feet above the top of the cab for horizontal wind. It must be even higher where the location is subject to steeply sloping winds resulting from deflection by the terrain, a common condition in mountainous terrain.

2. Any mounting system must be easily built and taken down. Instruments are usually exposed for only a few months during the fire season, and during this time they need periodic lubrication and inspection.

3. The instrument mounting must be securely fastened to the building, without appreciably obstructing vision, and with minimum modification of or damage to the lookout structure.

4. The instrument mounting cannot be above the lightning protection system, hence must become part of the system. One objective of the lightning protection is to minimize the hazard of side flashes between conductors of different potential. Differences in potential are minimized by bonding all conducting systems to the lookout lightning protection system. Details of how this is accomplished will vary with lookout construction as well as with design of lightning protection. In general, this requires (a) an adequate lookout lightning protection system;[2] (b) incorporation of the mast into the lightning protection system; (c) bonding of the leadin wires and the readout instrument to the system; and (d) locating the readout instruments close to a floor-level or below floor-level conductor of the lightning protection system.

These requirements are equally important whether the instruments are used for routine fire-danger or fire-weather reporting, or if they are installed only temporarily for a special study.

CATWALK CORNER-POST MOUNTING

The mast of the catwalk corner-post mounting system consists of several 5-foot sections of TV mast aluminum tubing and two sections of wooden doweling. It is anchored at the base, strapped to a railing corner post, and can be extended a section at a time to 25 feet or higher. The mast top is a pointed aluminum lightning rod exposed several feet above the wind instruments. Two of the units illustrated were used during one summer with the "S" type anemometer and vane shown (fig. 1).

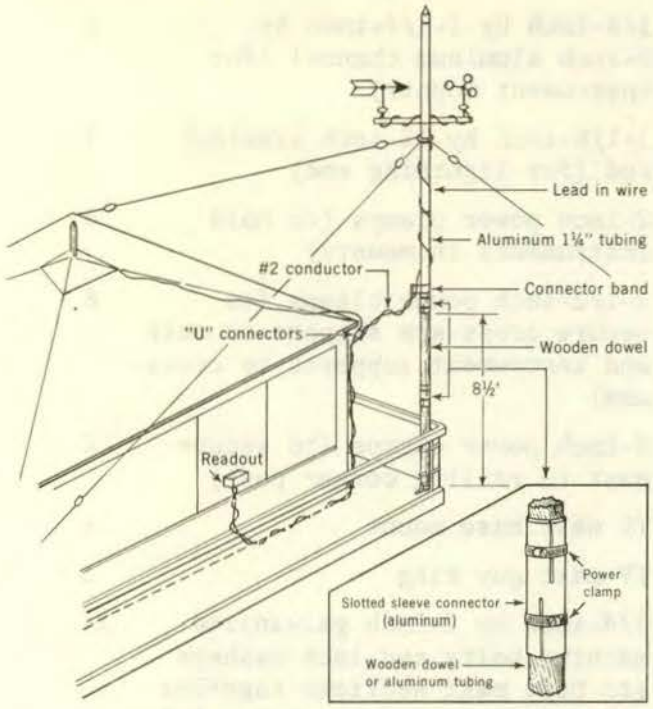

Figure 1.--*Schematic of catwalk corner-post mounting.*

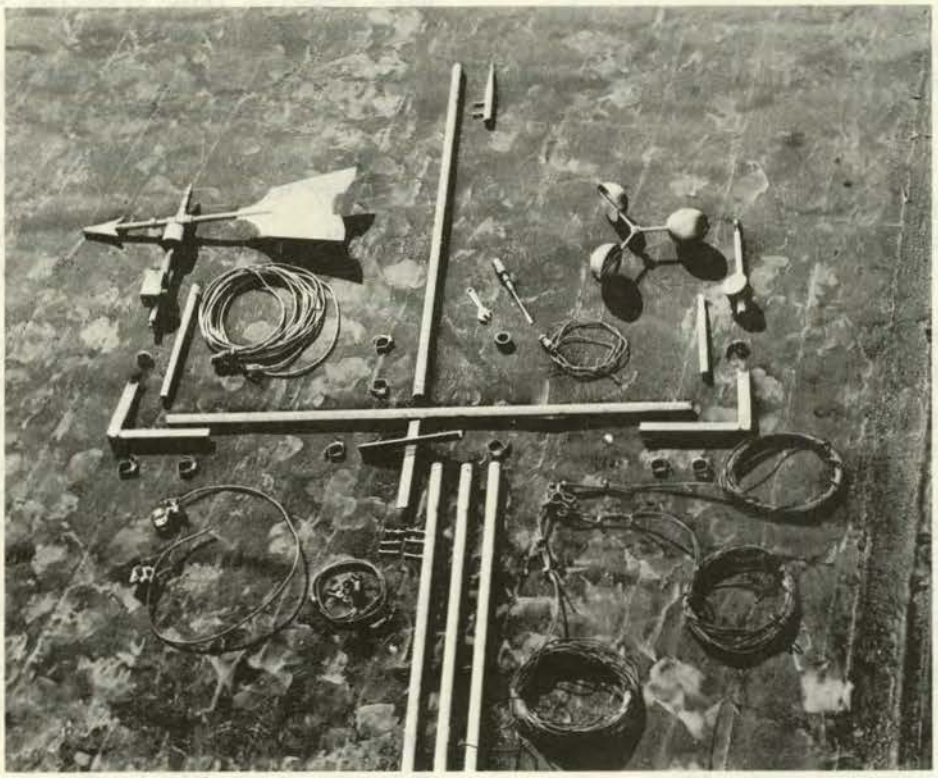

Figure 2.--*Mast components. Most parts are available as TV mast parts or common hardware.*

They proved much handier than the usual pole or 2- x 4-inch support. With a solid base plate this mast can also be used for surface installations.

Because of the danger of lightning side flashes between the lower mast and the lightning conductor descending the corner of the lookout building, the lower two sections of the mast are made of non-conducting material such as wood doweling (fig. 1).

Though most parts are standard hardware or TV mast items (fig. 2), three pieces of the instrument support arm require welding, and the lightning rod must be turned (fig. 3). Because of electrolytic action between aluminum and copper, copper connector bands must be tinned on surfaces in contact with the aluminum mast.

Unassembled, the mast is readily packaged for transportation or storage. With four 5-foot aluminum sections, it weighs 20 pounds exclusive of wind instruments. Total cost of parts and part fabrication was less than $25 exclusive of guy wire and lightning protection hardware. Except for below-the-floor hookups, two men can install or take down this mast in 2 hours.

PARTS

Parts for the catwalk corner-post mounting consist of the following:

Parts	*Amount*
1-1/4-inch by 5-foot aluminum tubing TV mast sections	3
1-1/4-inch by 5-foot wooden dowel (for bottom two sections of mast)	2
0.058-inch by 1-3/8-inch by 12-inch aluminum tubing with ends slotted about 3 inches (for sleeve connectors)	2
2-1/2-inch power clamps (to secure sleeve connectors)	4
3/16-inch by 1-1/4-inch by 12-inch aluminum angle (for cross-arm support and instrument mounts)	4
1/8-inch by 1-1/4-inch by 9-inch aluminum channel (for instrument mounts)	2
1-1/8-inch by 12-inch aluminum rod (for lightning rod)	1
2-inch power clamps (to hold instruments in mounts)	4
2-1/2-inch power clamps (to secure cross-arm support to mast and instrument supports to cross-arm)	8
8-inch power clamps (to secure mast to railing corner post)	2
TV mast base mount	1
TV mast guy ring	1
1/4-inch by 2-inch galvanized machine bolts and lock washers (to bolt mast sections together and lightning rod to mast. Bolts are also needed, to prevent the crossarm and two instrument mounts from twisting)	11
Wire U-bolts (for securing ends of three guy wires)	12
Sufficient bronze or stainless steel cable for three guy wires	--
2-inch strain insulators, two for each guy wire	6
12-inch sections of aluminum rod or pipe for mounting wind instruments	2
6-foot piece (approx.) of #2 copper conductor (to connect mast to lightning protection system)	1
2-inch "U" connectors[2] (to connect section of #2 conductor with mast and lightning protection system)	3
Tinned copper connector band #20 gage by 1-7/8-inch cold rolled copper, tinned on one side (to form contact with base of mast)	1
Tube Penetrox "A" by Burndy Corp. or equal (joint compound for tin-aluminum joint)	1

Parts	*Amount*
#6 copper wire and 2 "U" connectors (to ground readout instruments to #2 lightning conductor)	--

Some may prefer the heavier 1-inch aluminum pipe instead. However, the 1-1/4-inch aluminum tubing with a wall thickness of 0.044-inch has a conductive capacity twice that of a #2 copper conductor. This capacity is based on aluminum conductivity being 60 percent that of copper for identical size conductors. In the absence of ready-made TV mast sections, use structural aluminum tubing, 60-61 T6 alloy, 0.058-inch x 1-1/4-inch (or heavier) for the 5-foot sections. These may be joined with 1-foot sections 0.058-inch x 1-3/8-inch tubing used as slotted-end sleeve connectors held in place with power clamps.

FABRICATION

The lightning rod will need to be turned--one end to fit into the mast top, and the other to form a 45° point (the point in fig. 3 is too thin). Holes are needed for bolts to hold the rod in place and to provide good electrical contact.

The two instrument mountings and the cross-arm support require welding at 90° angles (fig. 3). The supports can be moved to any desired position on the cross arm and secured with power clamps. To avoid any possibility of the crossarm twisting owing to wind-induced torque, single bolts should be used to secure the crossarm to its support, and to secure the two instrument supports to the crossarm. Bolt holes for several possible positions may be provided at each end of the crossarm.

Mast joints are bolted to assure a snug fit and good electrical contact. We suggest two holes, 2-3 inches apart, and at 90° angles to each other at each joint. To simplify assembly, joining parts should be marked as soon as holes are bored. Wooden doweling will need to be fitted to mast tubing and sleeve connector.

Though aluminum has the advantage of light weight, it also causes a problem. Because the two metals used in this system are copper and aluminum, corrosion by electrolytic action is a real danger unless special precautions are taken. Wherever these two metals touch, the aluminum will be eaten away, destroying the contact. Therefore, the copper connector bands attached to the aluminum mast must be tinned on the surface next to the aluminum. Pure tin is required--not solder. To further insure a good contact, a special compound is used in the tin-aluminum joint. The tin may be applied to the connector band in several ways, but probably the simplest is to dip freshly scoured copper in melted tin.

ASSEMBLY AND INSTALLATION

The mast is readily assembled by two men using screwdrivers, crescent wrenches, and pliers. But its attachment to the lightning protection system may in some cases be more involved. To install the catwalk corner-post mounting, follow these steps:

1. Install bottom section (dowel) of mast and check for verticality (fig. 1).

2. Assemble the crossarm and attach near the lower end of the top section of mast to which lightning rod has been bolted. For greatest protection from lightning, instruments on the crossarm should be located close to the central mast and well below the lightning rod.

3. Attach instruments and tape lead wires to supports, crossarm, and mast.

4. Attach guy wires immediately beneath crossarm. Place insulators near upper end of each guy. Check orientation of vane in relation to guys.

5. Grease mast joints so they will slip together and apart easily.

6. Attach the lightning protection to the base of the third section up, that is, just above the wooden dowel (fig. 1). To assure a good contact, only tin--not copper--must be in contact with the aluminum mast. The tinned inner surface of the copper connector band

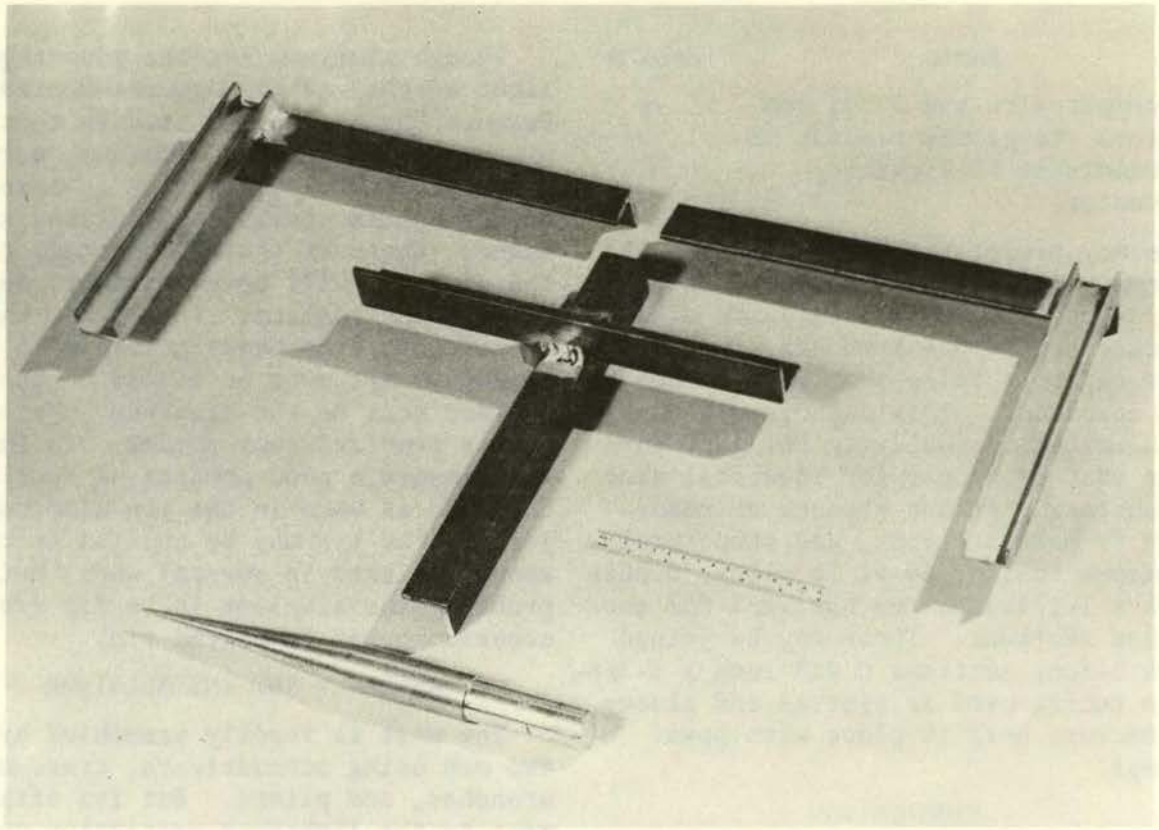

Figure 3.--*Fabricated aluminum parts--lightning rod, crossarm support, and two instrument mounts. Rod point should be 45°.*

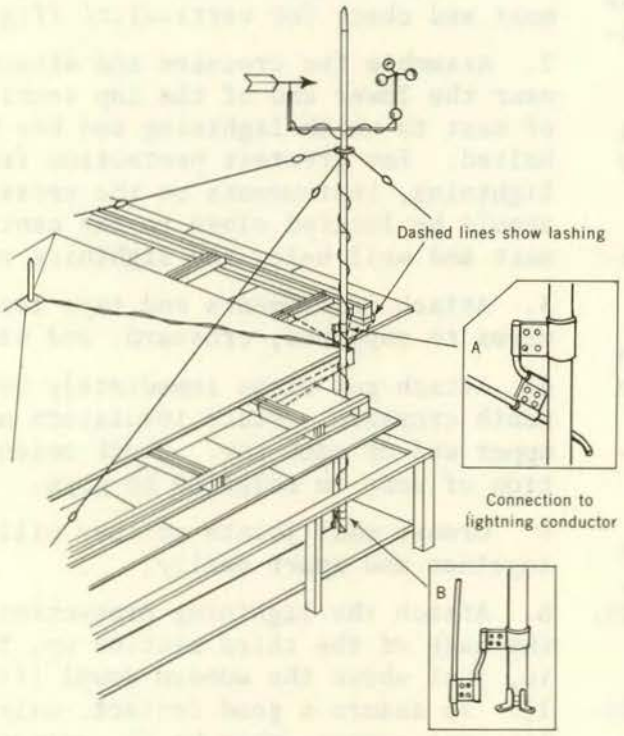

Figure 4.--*Building-corner catwalk mounting.*

should be covered with a thin layer of Penetrox "A". The connection must be tight to assure complete surface-to-surface contact and to keep water out of the joint.

The No. 2 conductor must be installed to pass from mast to lightning protection system no lower than 8-1/2 feet above the catwalk. The conductor will have two right angle bends both of which must have a radius of curvature no less than 8 inches (fig. 1).

7. Lift the top section and slip on successive sections of mast, bolting the joints and taping on the lead-in wires. Orient the mast, secure the bottom joint, and tighten the guys.

8. Connect the lightning conductor from the mast to the lookout lightning conductor at the corner of the roof.

9. Locate readout instruments within the lookout close to a lightning conductor at or below floor level to which the instrument cases must be grounded with No. 6 copper wire.

10. Lead-in wires should follow the lightning system conductor and ground wire all the way to the instrument case, be taped or tied to the lightning conductor at intervals, and enter the lookout at or below floor level.

11. If below-the-floor wiring is necessary, it can sometimes be simplified by locating both the mast and the readout instruments to permit access from the first stair landing beneath the cab.

BUILDING-CORNER CATWALK MOUNTING

An alternative catwalk mounting may be preferable on some lookouts. The mast would be located close to the corner of the building just far enough from the wall to provide a vertical mounting and to assure that the mast itself does not actually touch the lookout lightning protection system (fig. 4). For this design the entire mast would be aluminum tubing and would be connected to the lightning protection system at both the roof and floor levels. Other installation features would be similar to the catwalk corner-post mounting. The mast would be secured at roof level by lashing to the two adjacent shutter-support beams.

FLAT-TOP LOOKOUT CENTER MOUNTING

A roof-top mounting is needed for those lookouts with flat, overhanging roofs. Here the mast is located near the central lightning rod (fig. 5). Because copper and aluminum are incompatible, the mast cannot touch the copper lightning rod. Some differences in parts and assembly procedures from the corner-post mounting are necessary (fig. 6).

Parts	*Amount*
1-inch inside diameter (1.315-inch o.d.) 5-foot sections of aluminum pipe. Pipe is recommended by the Forest Service Electronics Center at Beltsville. The 1-inch pipe has more than twice the conducting capacity of the 1-1/4-inch tubing	4
Nu Rail or equivalent slip-on aluminum pipe couplings with set screws for 1-inch aluminum pipe	3
tinned copper connector bands or zinc-to-aluminum clamps (to attach "U" connectors and No. 2 conductors to base of mast)	2
2-inch "U" connectors (to connect connector bands on mast base to No. 2 conductor and the No. 2 conductor to main lightning protection system)	6
No. 2 conductor pieces about 2-feet long	2
base plate 3/4-inch by 8-inch by 8-inch outside plywood and screws	1
guy wires of bronze or stainless steel cable	4
2-inch strain insulators	8
"U" bolts (for guy wires)	24
4-inch galvanized screw eyes (to anchor guys)	4

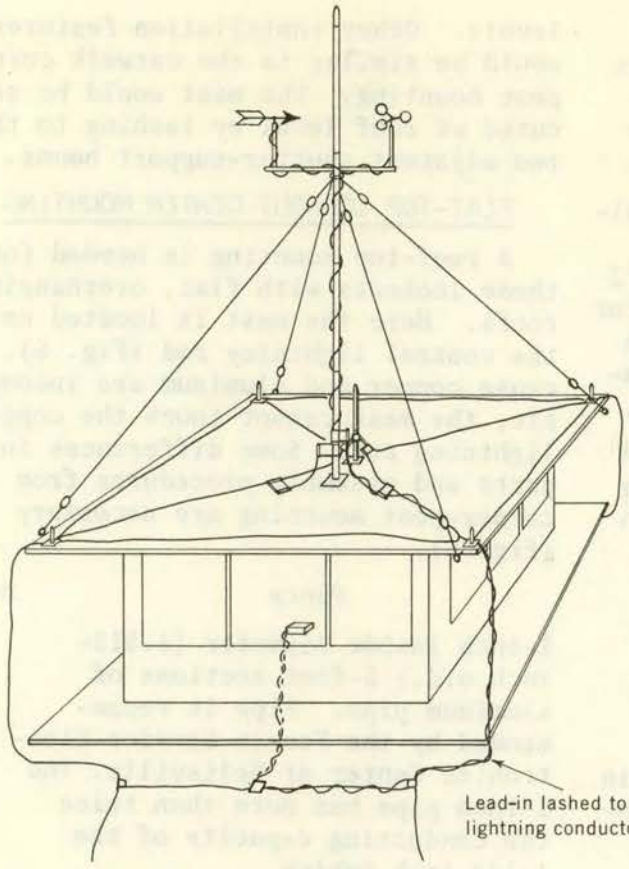

Figure 5.--*Flat-roofed lookout center mounting.*

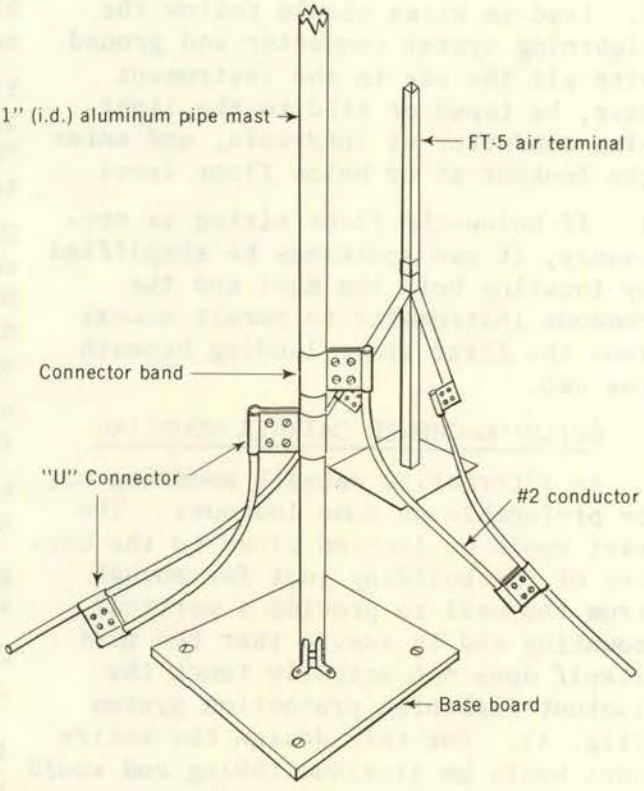

Figure 6.--*Connection of mast base to lightning protection system.*

ASSEMBLY AND INSTALLATION

1. Attach two tinned copper connector bands to the base of the mast with "U" connectors as in No. 6 above (fig. 6).

2. Secure the plywood base plate with TV-mast base mount already attached, to the roof deck with screws. A small amount of roof patching compound around each screw will prevent roof leaks.

3. Install four screw-eyes in roof edge near corners for guy anchors (follow assembly instructions 2-5 and 7 as for corner-post mounting)

4. Using the No. 2 conductors and doubled "U" connectors, connect the mast base to the two closest diagonal No. 2 conductors of the lightning protection system (follow assembly instructions 9-11 for corner-post mounting)

The designs specified for this note have incorporated the suggestions of the U.S. Forest Service Electronics Center, Beltsville, Md., and others, but have not been tested by being struck by lightning.

FOOTNOTES

[1]Based on U.S. Weather Bureau Memorandum 0 4 22, Feb. 19, 1960, subject: wind variation with height, Washington, D.C.

[2]Detailed specifications for lightning protection system parts may be found in U.S. Forest Service *Lightning Protection Handbook* 5651.32, Washington, D.C.

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