

TECHNICAL DEVELOPMENT REPORT NO. 109

VHF ANTENNA CHARACTERISTICS

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# VHF ANTENNA CHARACTERISTICS

## SUMMARY

This report covers the measurement of voltage standing wave ratio (VSWR) with frequency change and polarization characteristics of several types of antennas submitted to the Technical Development and Evaluation Center by the Office of Federal Airways.

The VSWR measurements were made over the band 100 to 140 Mc, and horizontal plane patterns of the vertical and horizontal components of the radiation field for each antenna were obtained at one frequency. The antennas were designed to match a transmission line having a characteristic impedance of 52 ohms. All measurements were made with the antennas mounted approximately seven feet above the counterpoise, which was elevated ten feet above ground.

Three of the five antennas tested were circularly polarized, their VSWR and polarization characteristics differing only in the magnitude of VSWR and the ratio of the fields of the vertical to horizontal components taken in the horizontal plane.

The VSWR and polarization characteristics of the two coaxial antennas were similar as would be expected. The horizontally polarized component radiated from these antennas was found to be negligible.

The antennas tested were

<u>Type No.</u>	<u>Manufacturer</u>	<u>Polarization</u>
CA-1350	Maryland Electronic Manufacturing Corp.	Circular
CA-1246	Bendix Radio	Circular
CA-1371	Andrew Company	Circular
- -	Aircon Manufacturing Company	Vertical (coaxial)
- -	Andrew Company	Vertical (coaxial)

Figs. 1 to 5 inclusive show the general construction and physical dimensions of each antenna. Types CA-1350, CA-1246, and CA-1371 antennas are equipped with Type UG-58/U receptacles to facilitate connection to the RG 8/U transmission cable. The antenna elements are connected across the

center conductor and shell of the receptacles, the orientation of the antenna elements being such as to produce the desired field patterns.

The Aireon coaxial antenna is equipped with a Type B-83-IR receptacle, the inner conductor of which is connected to the upper half of the antenna, while the lower half of the antenna (sleeve) is connected to the shell.

The Andrew coaxial antenna requires the center conductor of the transmission cable to be soldered to the upper half of the antenna and the lower half of the antenna (sleeve) to be connected to the braid, or outer conductor of the cable.

The antennas are provided with threaded couplings to permit mounting on top of a steel pipe.

#### TEST EQUIPMENT

The VSWR measurements were made with the Andrew Company Type 3100 slotted line having a characteristic impedance of 52 ohms. A Ferris Type 18-C radio frequency signal generator was used to excite the antennas under test.

A Type TML transmitter and a calibrated field detector were used to obtain the horizontal plane field patterns. Provision was made to rotate the antennas under test through an angle of 360 degrees.

#### TESTS

Tests were conducted with the antennas mounted approximately seven feet (center of radiation) above a 15-foot diameter counterpoise elevated ten feet above ground. The counterpoise was capable of rotation through an angle of 360 degrees.

Output power limitations from the radio frequency signal generator restricted the line VSWR measurements to the frequency band 100 to 140 Mc. Measurements were obtained at each four-Mc step within the band. Figs. 6 to 10 inclusive present values of VSWR as a function of frequency for the five different types of antennas.

The Type CA-1350 antenna produced the lowest VSWR values of the group, having a minimum value of 1.05 at a frequency of 110 Mc and maximum values of approximately 2.7 at the extreme ends of the frequency band 100 and 140 Mc. See Fig. 6.

Fig. 7 indicates a minimum VSWR of 1.07 at a frequency of 120 Mc and a maximum VSWR of 5.15 at a frequency of 104 Mc for the Type CA-1246 antenna.

Referring to Fig. 8, the Type CA-1371 antenna produced a minimum VSWR of 1.10 at a frequency of 125 Mc and a maximum VSWR of 3.1 at 100 Mc.

The two coaxial antennas produced a minimum VSWR of 1.40 at 120 Mc and maximum VSWR values of 7.70 and 6.40 respectively at approximately 106 Mc. See Figs. 9 and 10.

Types CA-1350 and CA-1371 antennas exhibit fairly broad band frequency characteristics and may be operated over the major portion of the frequency band without the necessity of using matching stubs. A VSWR of 2/1 usually can be tolerated without excessive loss of power when using Type RG 8/U cable. Type CA-1246 antenna and the two coaxial antennas (Figs. 9 and 10) are more frequency conscious and may be operated over a bandwidth of 10 or 12 Mc without the use of matching stubs.

The horizontal plane field patterns were obtained at a frequency of 113.7 Mc. The antennas were rotated through an angle of 360 degrees and the field intensity values obtained for each 20-degree rotation of the antenna.

Figs. 11 to 15 inclusive present the polarization characteristics of the five antennas. The horizontal plane patterns in Figs. 11, 12, and 13 each compare the amount of horizontally polarized field intensity with the vertically polarized field intensity, measured with the transmitting antenna 17 feet above ground, the field meter antenna 12 feet above ground, and the horizontal distance between the two antennas 180 feet. Under these conditions, if the transmitting antenna radiates equal amounts of vertically and horizontally polarized energy, the field meter will indicate a ratio of horizontal to vertical field intensity of approximately 1.47. The following is a comparison of the three antennas intended to radiate vertically and horizontally polarized fields:

<u>Antenna Type</u>	<u>Horizontal Field Intensity</u> <u>Vertical Field Intensity</u>
CA-1350	1.47
CA-1246	1.85
CA-1371	2.06

The CA-1350 antenna radiates equal amounts of horizontally and vertically polarized energy. The horizontally polarized field of the other two antennas is the greater.

It is interesting to note that, if the field intensities for the two polarized waves were measured at small angles of elevation (two degrees or less), the vertically and horizontally polarized fields of the CA-1350 antenna would be essentially equal over good conductivity soil.

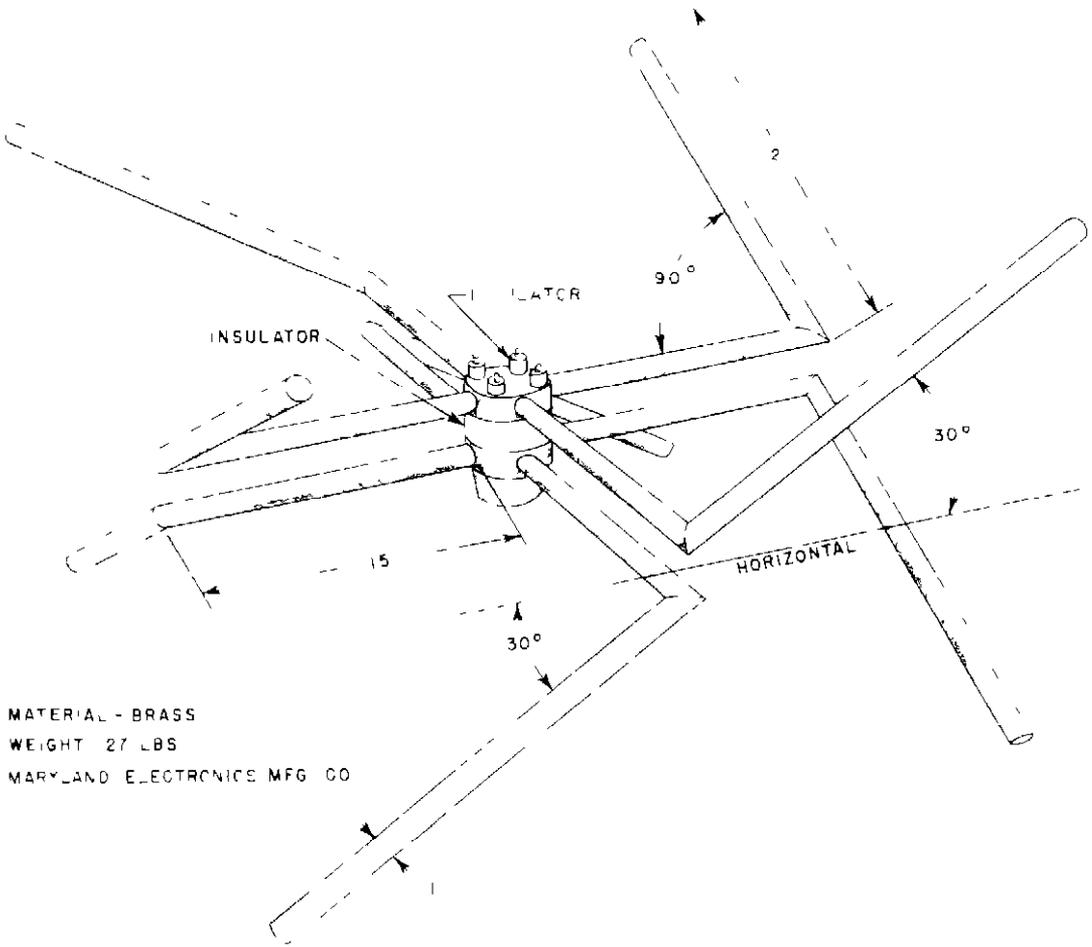
#### RECOMMENDATIONS

The Type CA-1350 antenna has the most favorable VSWR and polarization characteristics of the group tested. This is the only antenna of the

group which radiates equal amounts of vertically and horizontally polarized energy. All the other antennas radiate a greater proportion of horizontally polarized energy. This antenna is quite satisfactory for communication with aircraft in all directions except directly above. This criticism applies to all the antennas tested. Since little or no energy is radiated straight up from any one of the five antennas tested, an aircraft flying directly above or at high angles with respect to one of these antennas would be in a null, resulting in temporary loss of signals.

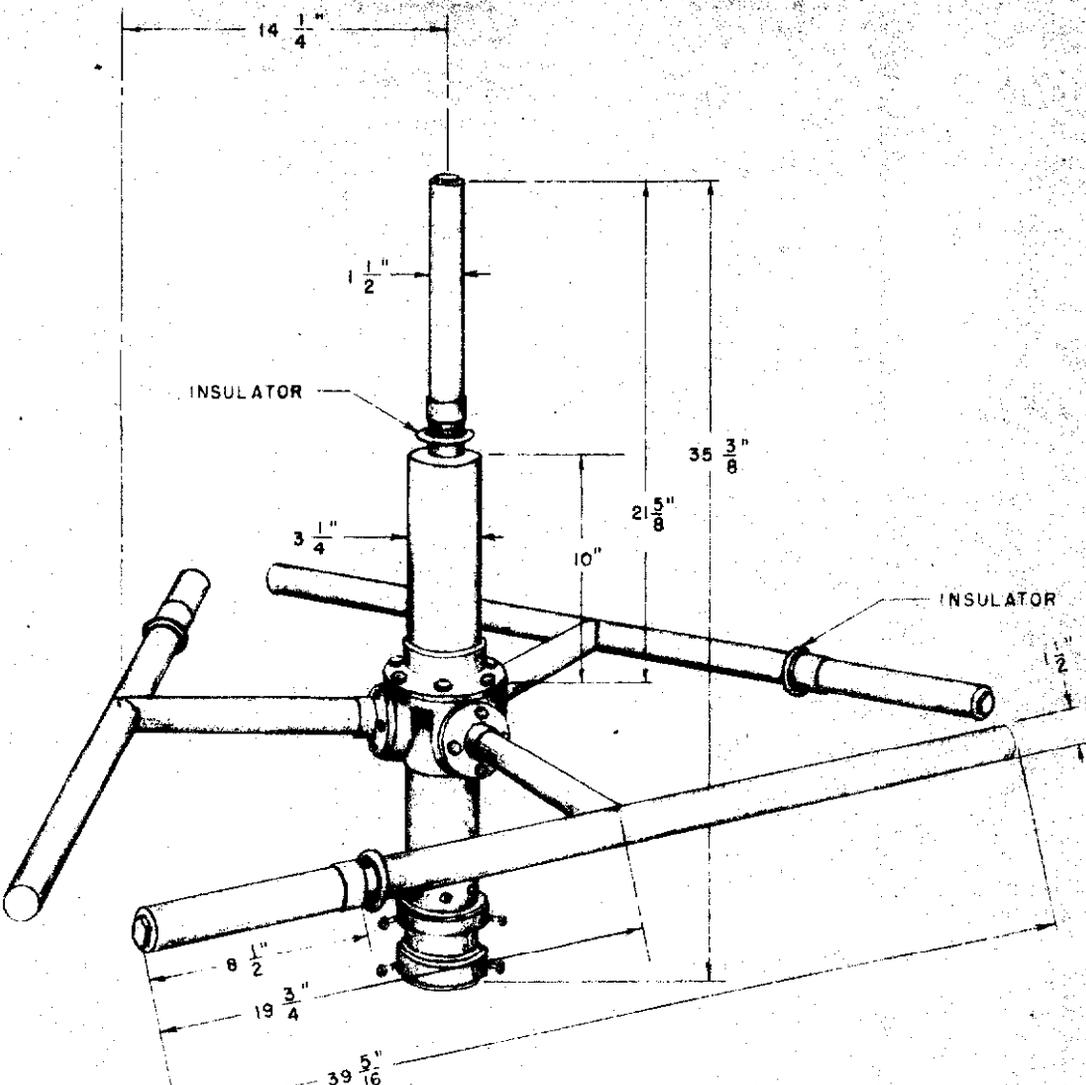
#### CONCLUSIONS

The VSWR and polarization characteristics of each of the five antennas tested are quite satisfactory for communication purposes. However, for ground to aircraft communication, it is particularly desirable to have antennas which are responsive to vertically polarized and horizontally polarized radiations. In this respect the CA-1350 antenna would most nearly meet this requirement.



MATERIAL - BRASS  
WEIGHT 27 LBS  
MARYLAND ELECTRONICS MFG CO

FIGURE 1 ANTENNA TYPE CA 1350



MATERIAL -- BRASS  
 WEIGHT --  $49\frac{1}{2}$  LBS.  
 BENDIX CO.

FIGURE 2. ANTENNA TYPE CA - 1246

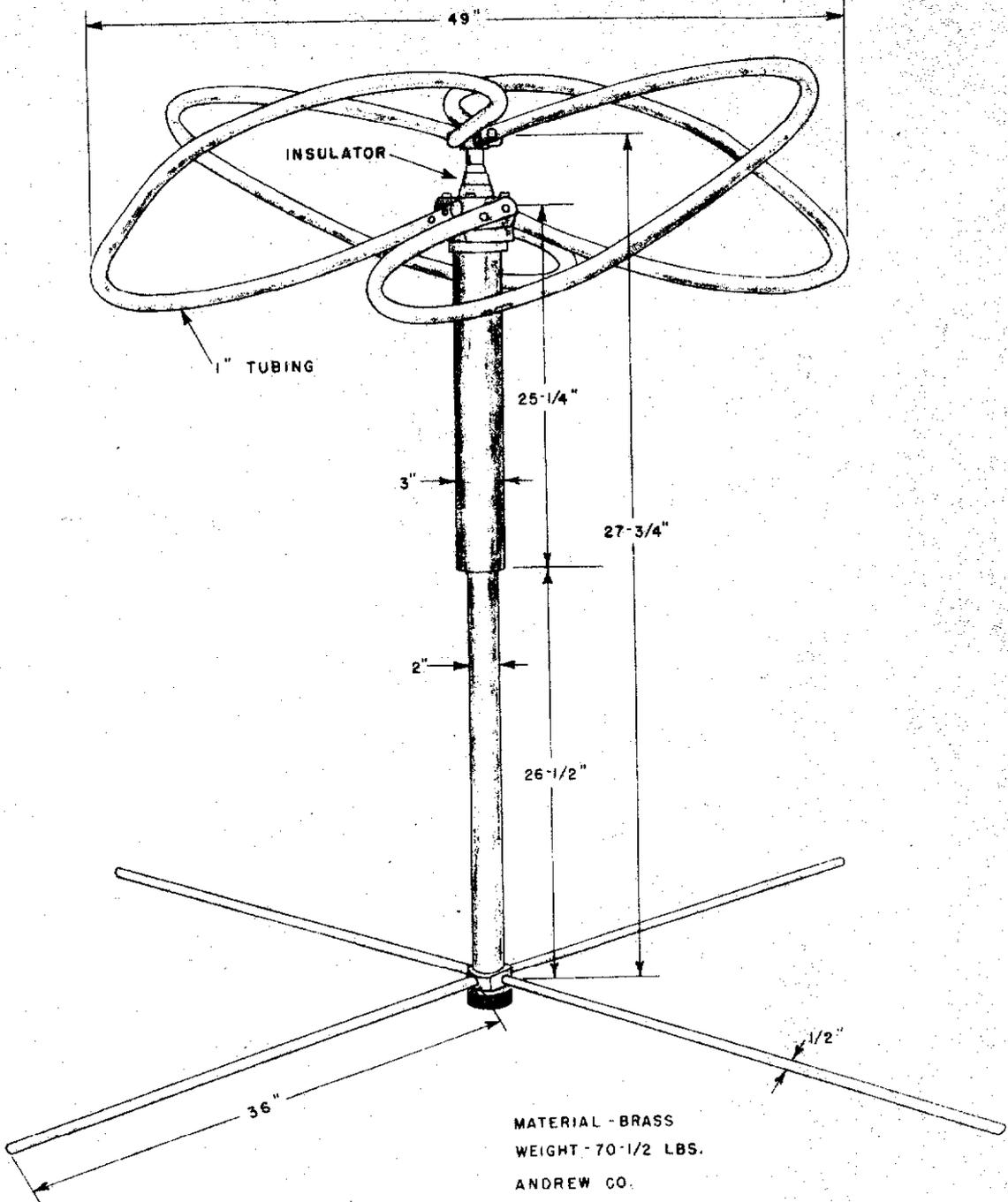
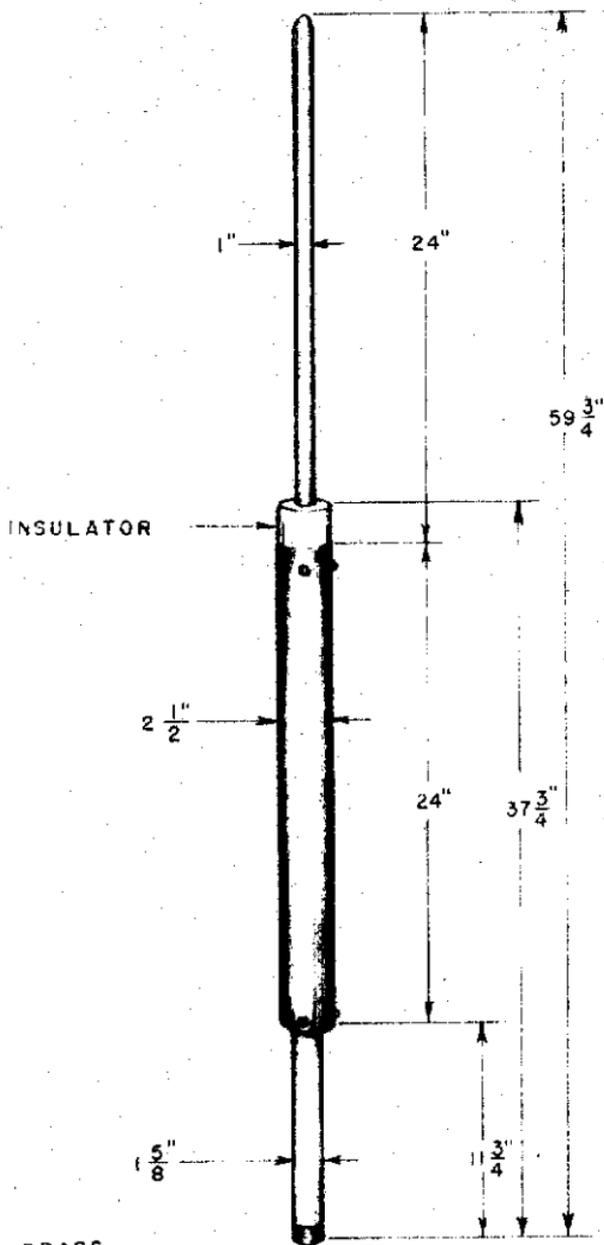
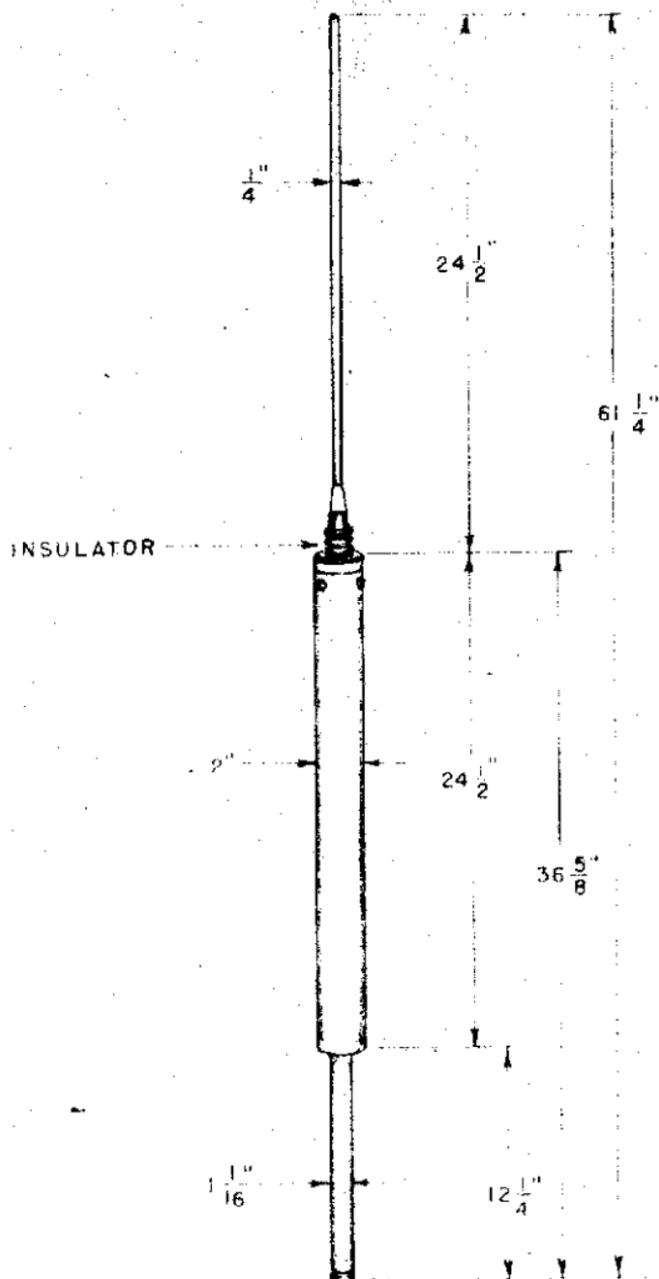


FIGURE 3. ANTENNA TYPE CA-1371



MATERIAL - BRASS  
 WEIGHT - 15 LBS  
 AIREON

FIGURE 4. AIREON COAXIAL ANTENNA



MATERIAL - BRASS  
 WEIGHT 8 LBS.  
 ANDREW CO.

FIGURE 5. ANDREW COAXIAL ANTENNA

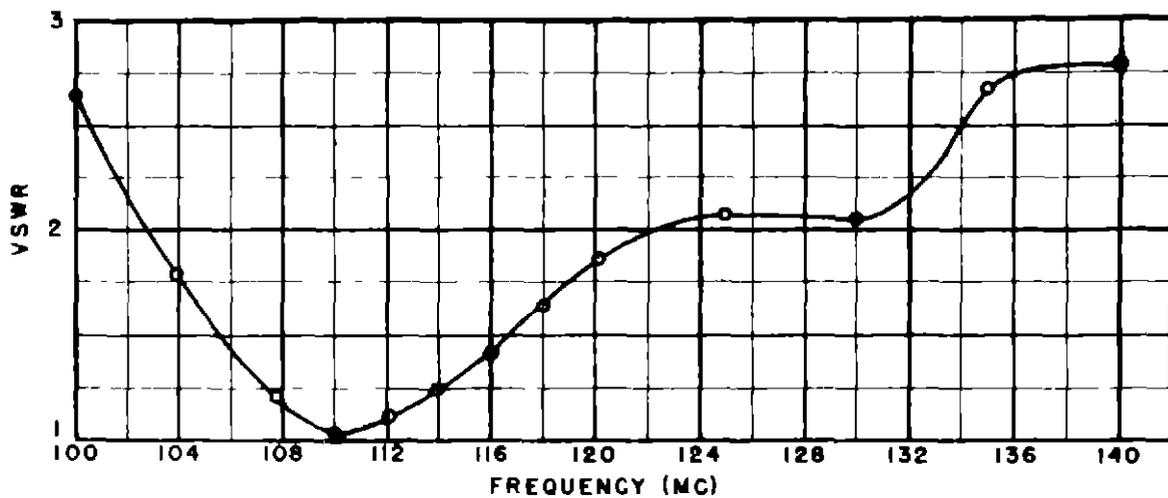


FIG. 6 VSWR VS. FREQUENCY (TYPE CA-1350 ANTENNA)

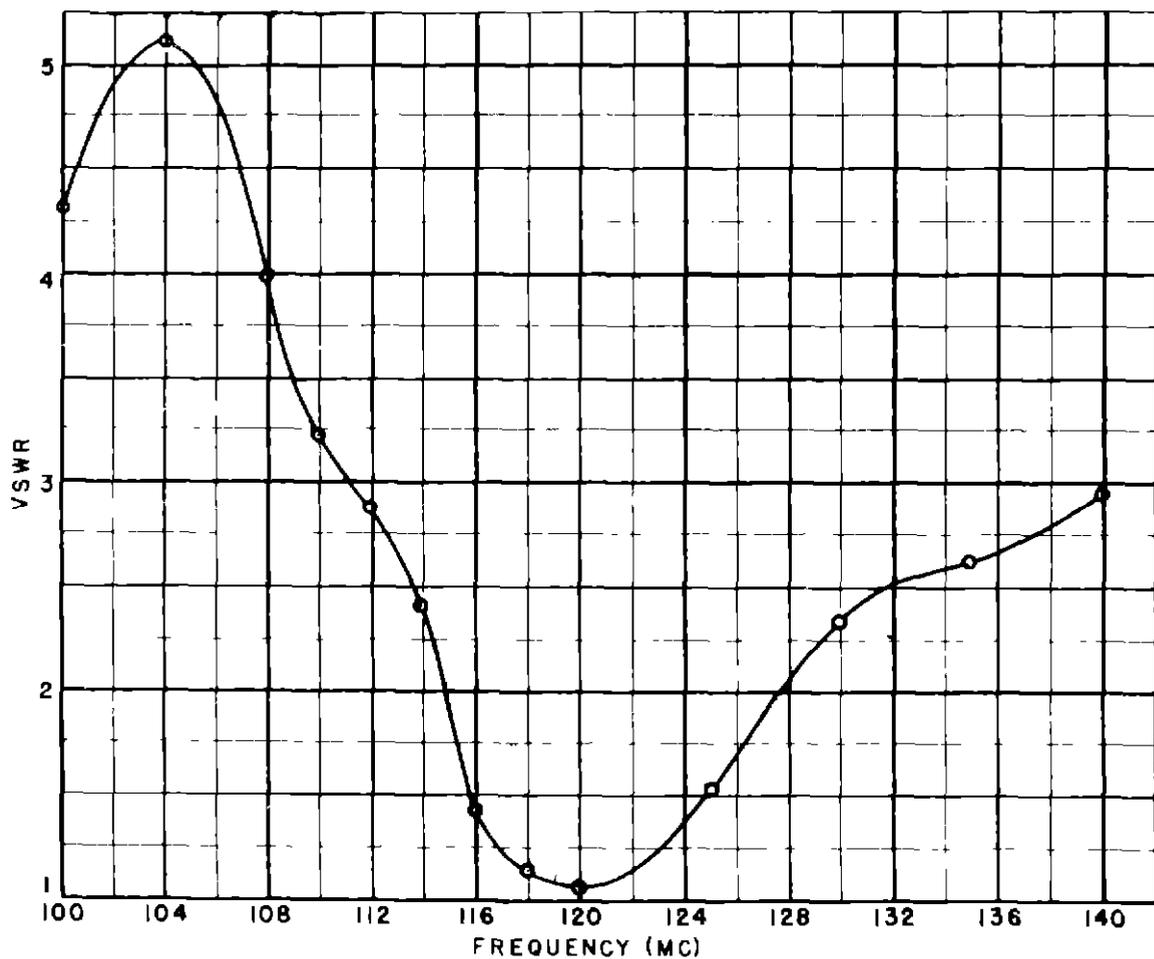


FIG. 7 VSWR VS. FREQUENCY (TYPE CA-1246 ANTENNA)

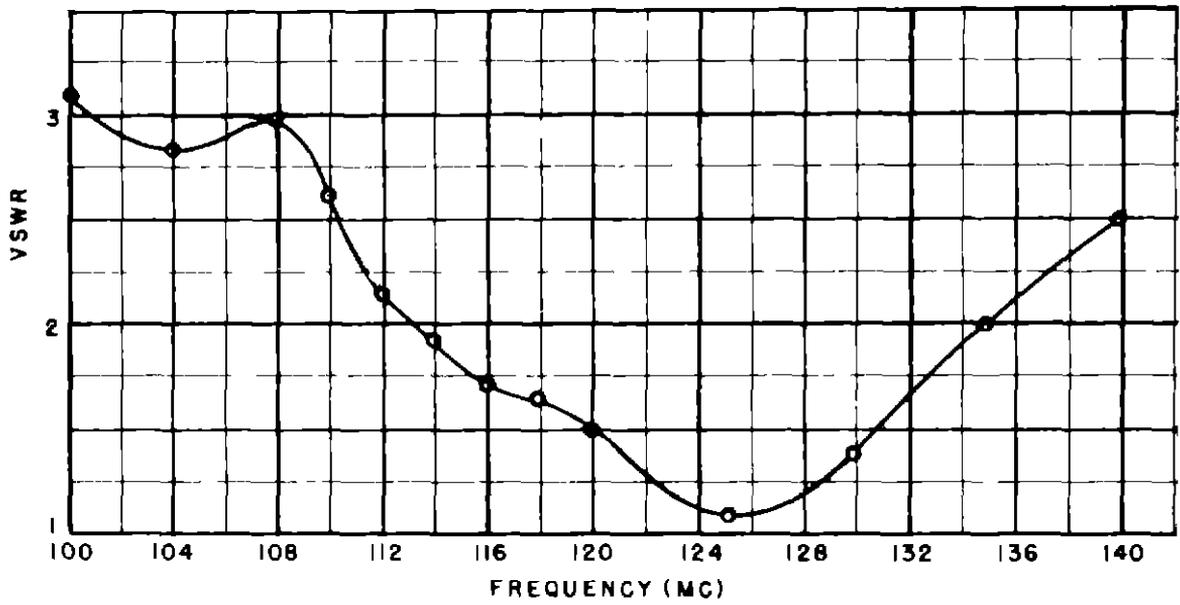


FIG 8 VSWR VS FREQUENCY (TYPE CA-1371 ANTENNA)

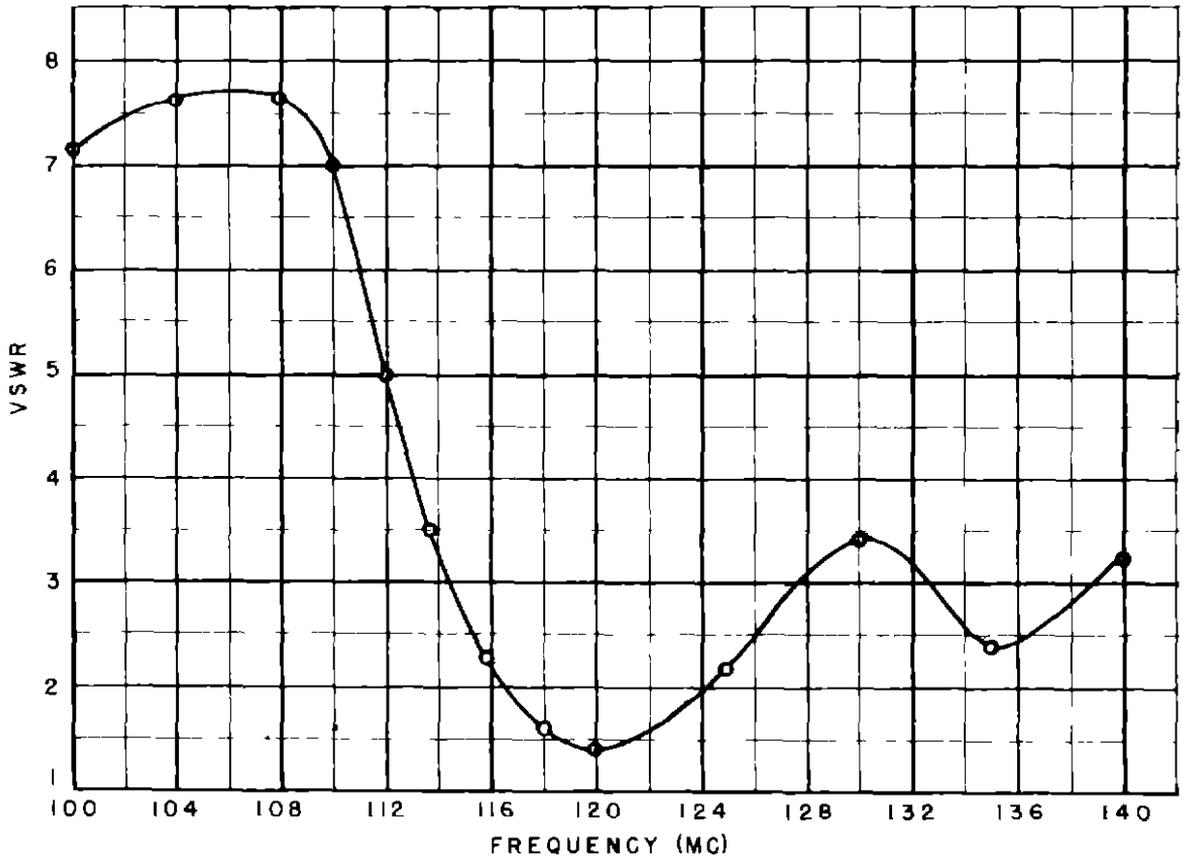


FIG 9 VSWR VS FREQUENCY (AIREON COAXIAL RECEIVER ANTENNA)

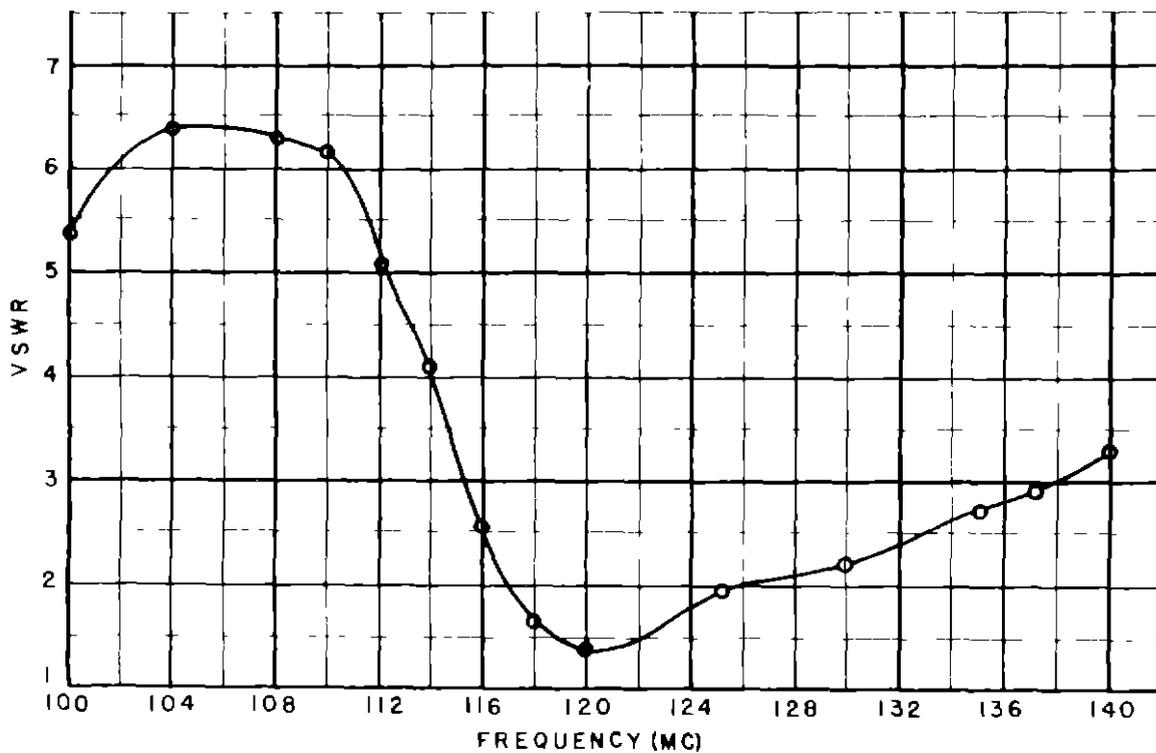


FIG 10 VSWR VS FREQUENCY (ANDREW COAXIAL RECEIVER ANTENNA)

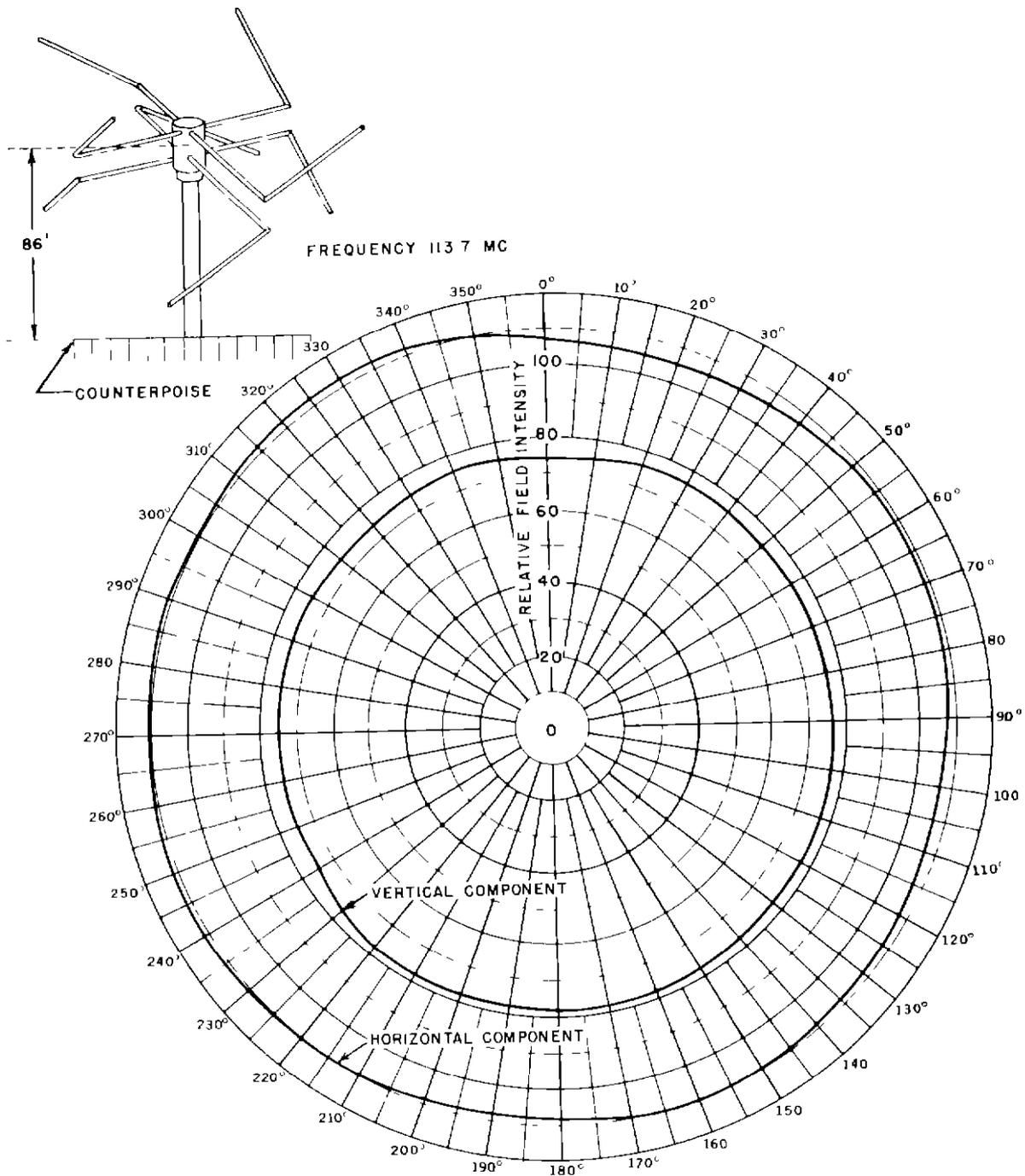


FIG 11 HORIZONTAL PLANE PATTERNS (TYPE CA-1350 ANTENNA)

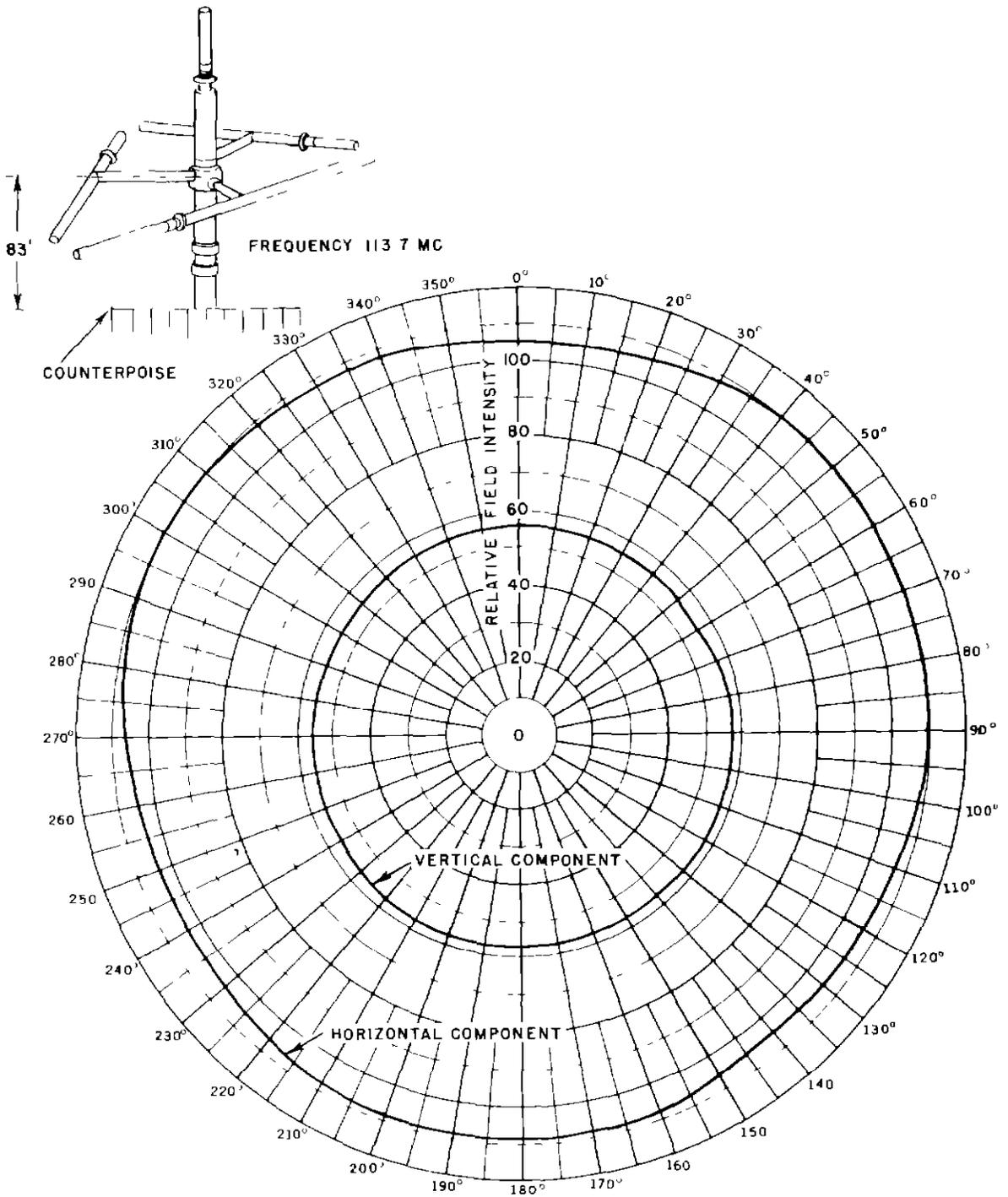


FIG 12 HORIZONTAL PLANE PATTERNS (TYPE CA-1246 ANTENNA)

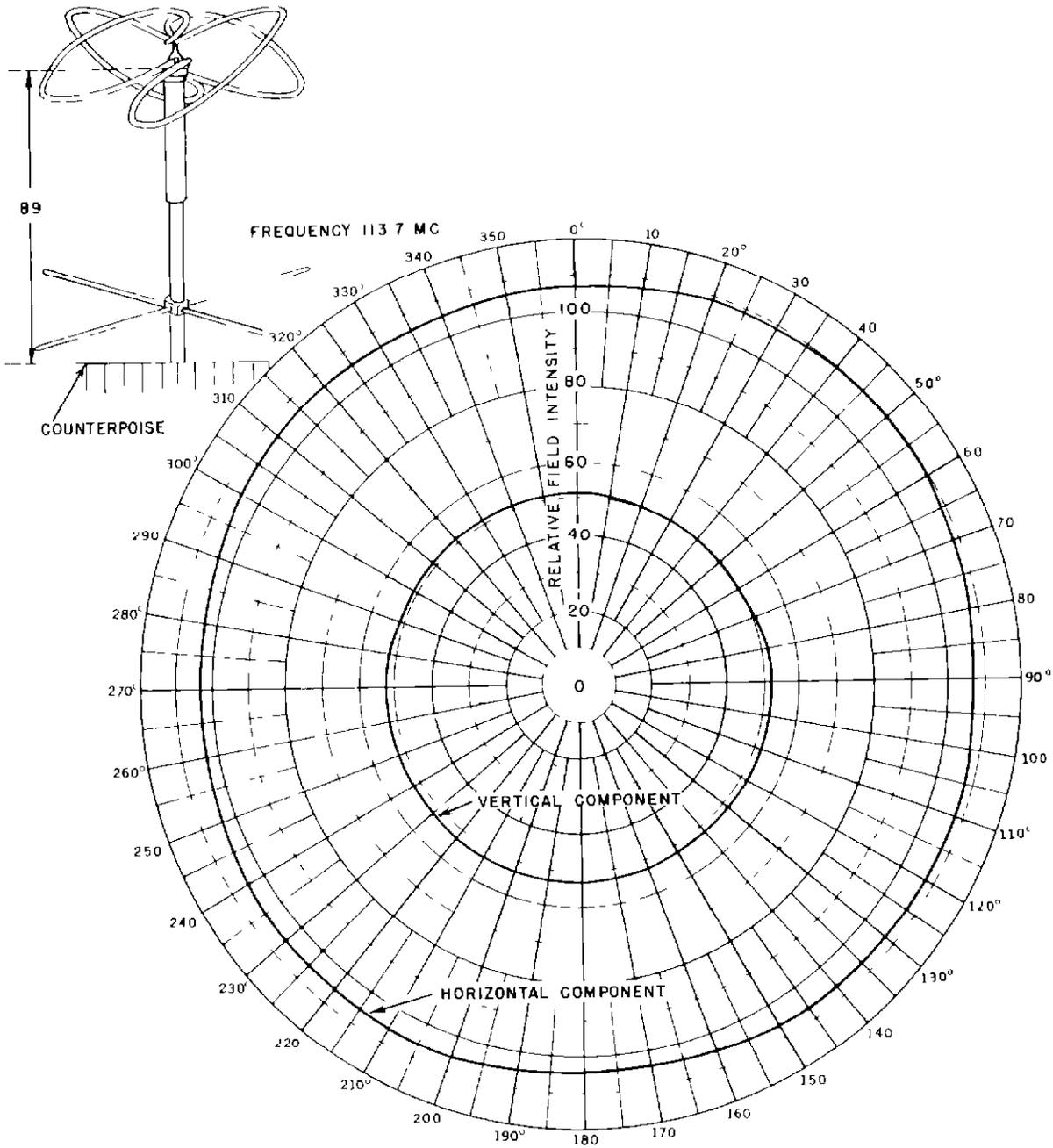


FIG 13 HORIZONTAL PLANE PATTERNS (TYPE CA-1371 ANTENNA)

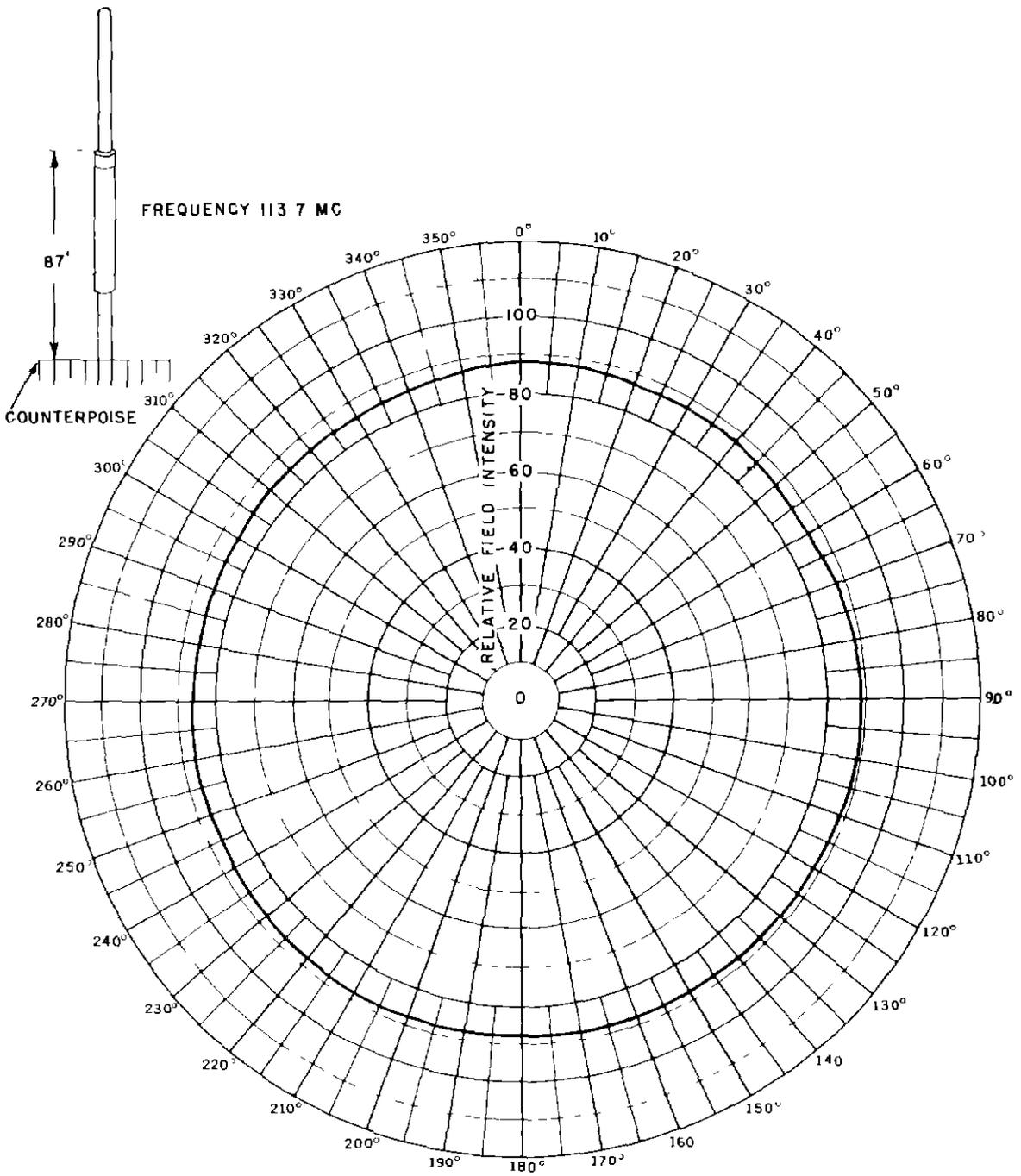


FIG 14 HORIZONTAL PLANE PATTERN (AIREON COAXIAL ANTENNA)

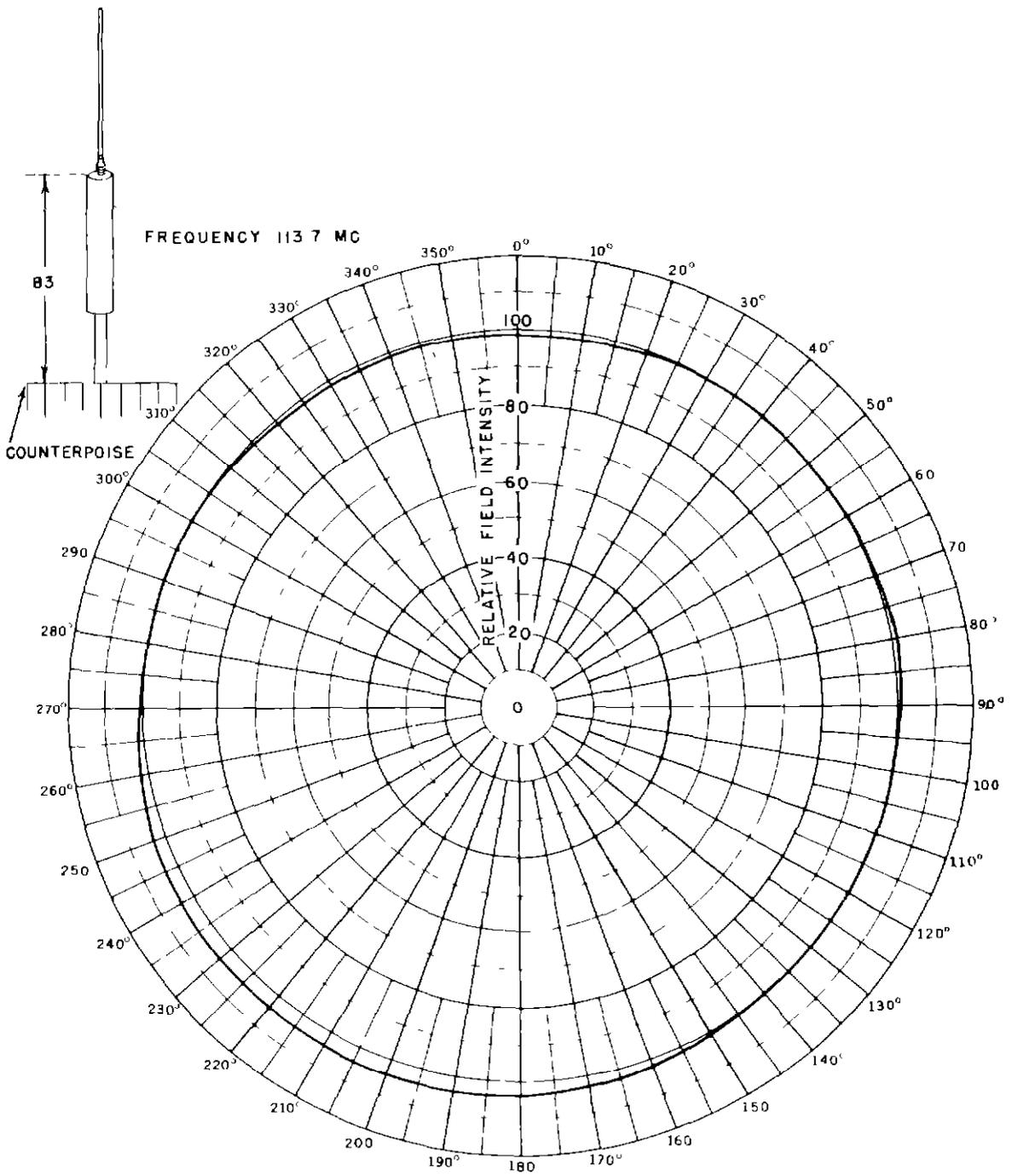


FIG 15 HORIZONTAL PLANE PATTERN (ANDREW COAXIAL ANTENNA)