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SHORT AXIAL LENGTH BROADBAND HORNS

by

John L. Kerr

October 1970

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TECHNICAL REPORT ECOM-3344

SHORT AXIAL LENGTH BROADBAND HORNS

By

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Combat Surveillance, Target Acquisition and Systems Integration Laboratory

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US ARMY ELECTRONICS COMMAND
FORT MONMOUTH, NEW JERSEY

ABSTRACT

This report describes the development of two very broadband horns in which a substantial reduction in axial length, over that of earlier models, has been achieved. A significant requirement for both models is that of maintaining the half-power beamwidth greater than thirty degrees over the very broad bandwidths involved.

The first horn developed covers the frequency range from 1 GHz to 12 GHz with the flared portion of the horn having an axial length of six inches as compared with twelve inches for a previous design. The short axial length design was used as a basis in developing a very reasonably sized antenna operating in the range from 0.2 GHz to 2.0 GHz. A technique of fabricating the H-plane walls in the form of a grid was used in both horns as a means of controlling the H-plane patterns. The grid for the 1 GHz to 12 GHz horn was fabricated in printed circuit form while the grid elements of the lower frequency horn were made of aluminum tubing.

Electrical performance characteristics of both models are presented in the form of radiation patterns, VSWR, and gain curves.

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FIGURES

SHORT AXIAL LENGTH BROADBAND HORNS

INTRODUCTION

Over the past several years, personnel of this Laboratory have been engaged in the development of very broadband horn antennas utilizing double-ridged waveguide techniques.[1] Some very early work, for countermeasures applications, resulted in the design of several feed horns which exhibited bandwidths of slightly more than three to one. During that effort, the possibility of achieving greatly increased bandwidths was recognized but little additional work was done for a period of some six years. Increased bandwidth requirements, for radio frequency interference measurements, revived the program and resulted in the design of a feed horn having a six-to-one bandwidth, covering the frequency range from 1.8 GHz to 10.8 GHz. The horn was used to illuminate a four-foot parabolic reflector for a high-gain application. Since it was still the goal to cover the entire frequency range from 1 GHz to 12 GHz with a single antenna, additional effort was directed toward further increasing the bandwidth. That work, also for RFI applications, has resulted in achieving bandwidths in excess of twelve to one for two horn designs[2] to meet separate sets of requirements in the 1 GHz to 12 GHz frequency range. The first design accomplished in that program was for a feed horn which was used with a six-foot parabolic reflector. The feed-horn design was followed by the development of a moderate-gain horn (about 15 db) with a significant requirement that the gain variation be held to a minimum over the twelve-to-one band.

An attempt was later made to use the latter two horns in another RFI application. Those measurements indicated a need to maintain wider half-power beamwidths over the band than is the case for either of the two designs available. As a result, a requirement existed for a horn to cover the 1 GHz to 12 GHz frequency range, where the half-power beamwidth would not become less than thirty degrees and with a goal of not less than forty degrees.

It was found, near the end of the development of the broadband feed horn, that a small linear taper superimposed on the logarithmic curve of the ridges tended to give a substantial improvement in VSWR at the low end of the frequency range and had little effect elsewhere. It then appeared likely that the twelve-inch axial length of the horn flare could be significantly reduced. That was, indeed, found to be so in a model with an axial length of six inches. The original short model is shown in Figure 1. Pattern data showed that in the H-plane at some frequencies the half-power beamwidth became less than thirty degrees. Also, pattern deterioration was found to be severe above 10 GHz. Nevertheless, the short axial length model appeared to be a good starting point in arriving at a design to meet the new requirements.

Similar requirements also existed for an antenna to cover the 0.2 GHz to 1.0 GHz frequency range. The short axial length design appeared attractive for this purpose also, since scaling by a factor of five would result in a maximum dimension of 37.5 inches. The five-to-one bandwidth requirement indicates that only the lower portion of the total frequency range will be used where the half-power beamwidths are still wide enough and the pattern deterioration at the upper limit will not be encountered.

DESCRIPTION
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

As stated earlier, the original six-inch axial length design exhibited pattern deterioration above 10 GHz. The same characteristic was encountered earlier in the design of a moderate-gain horn as discussed in reference 2. In that instance, the launcher section was found to be the major source of the problem, and a new launcher was designed which permitted operation to 12 GHz. In an effort to meet the full bandwidth requirements for this development, the six-inch axial length horn design was combined with the modified launcher.

The short axial length broadband horn (Figure 2) consists of a short section (about 1.5 inches) of double-ridged waveguide with a coaxial input. The waveguide at the feed point is 1.2 inches wide x 0.872 inches high. That cross section is maintained for a distance of 0.325 inches back to a shorting plate (to the left in Figure 2). It is interesting to note that both the cross section of the launcher and the length of the back cavity are extremely small, with the length of the cavity being an order of magnitude smaller than usual for operation at the low end of the frequency range. From the center line of the coaxial input feed point, the size of the cavity increases from 1.2 inches by 0.872 inches to 3.4 inches by 2.616 inches at the waveguide-horn junction, which is one inch from the feed point (to the right in Figure 2). Figure 3 is the graph from which the ridge curvature was determined. The X-coordinates are axial distances along the center line of the antenna with X = 0 being located at the waveguide-horn junction. The Y-coordinates are perpendicular distances from the center line of the antenna to the ridge surface. As indicated on the graph, the amount of additional linear taper required for best VSWR in the first octave of the bandwidth was found to be 0.020X inches for the six-inch axial length horn. 0.020X inches is the largest amount found to date for three different horn designs in which that parameter has been determined. The smallest amount was 0.008X inches for a horn with an axial length of 12 inches and an aperture of 7.5 inches in the H-plane by 5.2 inches in the E-plane. The first version of the short axial length horn with the modified launcher had an aperture of 7.5 inches in the H-plane by 5.44 inches in the E-plane. Except for the launcher section, that version was the same as shown in Figure 1.

MEASURED CHARACTERISTICS
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

The performance characteristics of the development model were determined by measuring radiation patterns, VSWR, and gain over the frequency range of interest. These data showed that the bandwidth of the short axial length horn had been extended to cover the entire 1 GHz to 12 GHz band. The VSWR was quite satisfactory over the band and the E-plane half-power beamwidth was less than forty degrees in only one instance. In the H-plane, the half-power beamwidth was found to be on the order of twenty-five degrees in the range from 5 GHz to 6 GHz.

In an attempt to maintain a wider beamwidth in the H-plane, the aperture was increased from 7.5 inches to 9.5 inches in that plane. It was assumed that the additional phase error introduced by the larger flare angle would result in reduced aperture efficiency. Pattern data with the larger H-plane aperture showed a minimum half-power beamwidth of thirty degrees. However, the additional phase error caused the H-plane patterns in the range of 7 GHz to 8 GHz to have a shallow depression on the boresight axis which was not present before the modification. The maximum depth of the depression was on the order of 1 db and resulted in a further deepening of depressions (to about 1.5 db) present in the E-plane patterns before the modification. These were not considered of much consequence for the intended application except that, in reproducing the design, there is always the possibility of further deterioration. For that reason, an attempt was made to reduce the effect of the larger flare angle in the upper portion of the band.

In an earlier development,[3] it was shown (at least for a longer axial length) that the ridges have primary control of the radiation patterns in the upper portion of the band. In view of that, the sides of the horn which normally control the H-plane patterns (referred to as H-plane sides for the remainder of this report) were removed and a series of patterns taken. These show that from 3.5 GHz to 12 GHz the H-plane sides are not required. The H-plane patterns have no depressions on axis and the half-power beamwidth is more than thirty degrees. The small depressions (less than 1 db) are still present in the E-plane patterns. At lower frequencies, the H-plane patterns tend to broaden too much with the H-plane sides removed. The above results suggest the use of a grid type construction[4] for the H-plane walls. If the spacing between grid elements is on the order of 0.1 wavelength at the low end of the band, a plane reflector will be simulated. Over the large bandwidth of this horn design, the spacing will then be greater than one wavelength at the upper end of the band, and the grid should have very little effect there. On that basis, the development model was modified to include grid construction of the H-plane walls. Figure 4 is a photograph of the model after modification. The 0.093-inch aluminum rods are spaced a little more than 0.1 wavelength at 1 GHz.

Although the electrical characteristics of the model were quite satisfactory, it appeared that weatherproofing, if required for other applications, would present a problem. For that reason, a final modification was made which consisted of making the H-plane sides in the form of a printed circuit grid. Two types of aluminum clad material were obtained and etched. These were: 1/16-inch Custom Poly Teflon Fiberglass made by Custom Materials, Inc., and 1/16-inch polyphenylene oxide made by General Electric Company. Figure 5 is a photograph of the final version with the printed circuit grid construction. The grid is composed of six strips, 0.030 inches wide, which are equally spaced at 1.306-inch intervals. The end strips adjacent to the waveguide-horn junction would not be required electrically but were included as a reference line for machining operations after the etching process was completed. Electrical performance was the same for the two materials.

Figure 6 through 29 are representative E- and H-plane patterns plotted on a relative voltage scale. The H-plane half-power beamwidth exceeds thirty degrees throughout the frequency range and the narrowest E-plane pattern, which was recorded at 3.5 GHz, is thirty-six degrees. Figures 30 through 35 indicate how the printed circuit H-plane sides affect the patterns over the frequency range. Figures 30 and 31 show the patterns measured at 1.4 GHz with no H-plane sides and with the printed circuit sides. Here the grid construction gives essentially the same performance as that obtained with plane metal sides. Figures 32 and 33 present the comparison at 3.5 GHz. The printed circuit sides still have an effect but it is much reduced from that at 1.4 GHz. Figures 34 and 35 show that the effect of the grid construction on the main lobe is negligible at 10.5 GHz. Some additional side and back lobe radiation can be seen which is apparently due to small reflections from the grid elements.

Figure 36 shows the VSWR and gain as measured on the final development model with the printed circuit H-plane sides. The VSWR remains under 2:1 over most of the 1 GHz to 12 GHz frequency range and to a limited extent below 1 GHz, where the axial length of the horn is less than one-half wavelength. On the graph of measured gain, the term boresight gain is used to indicate that the measurements were made on the horn axis although that is not the direction of maximum gain in those instances cited earlier where the E-plane patterns exhibit a depression on axis.

DESCRIPTION
SHORT AXIAL LENGTH HORN (0.2 GHz - 2.0 GHz)

The original short axial length horn of Figure 1 appeared to be a likely starting point in developing an antenna to meet similar requirements in the 0.2 GHz to 1.0 GHz frequency range. The maximum dimension, when scaled by a factor of five, is 37.5 inches. That dimension is for the H-plane aperture and is approximately equal to the width required for a waveguide operating at 0.2 GHz. Another attractive feature is that the waveguide launcher for that design is much more easily fabricated in sheet metal form than is the launcher for the 1 GHz to 12 GHz design. Since the original bandwidth was only 5:1, the more complex launcher was not required, and over that limited range it appeared that the beamwidth requirement could easily be met with a directly scaled version of Figure 1.

A 5:1 scale model of the antenna shown in Figure 1 was designed and fabricated. That configuration is outlined in Figure 37. Scaling by a factor of five resulted in having a launcher section 6.625 inches long. The width of the launcher at the center line of the coaxial input feed point is 7 inches. That width is maintained for a distance of 1.625 inches back to a shorting plate (to the left in Figure 37). The width increases from 7 inches at the feed point to 14.2 inches at the launcher-horn junction, which is 5 inches away (to the right in Figure 37). The height of the launcher is 6.7 inches throughout. The tapered section of the antenna has an axial length of 30 inches and increases in size from 7 inches by 6.7 inches at the launcher-horn junction to 37.5 inches in the H-plane by 27.2 inches in the E-plane at the horn aperture. The distance between the ridge surfaces increases from 0.250 inches to 27.2 inches over the same 30-inch axial length. Figure 38 is the graph from which the ridge curvature was determined. Figure 39 is a photograph of the original development model. The horn and launcher were fabricated of 0.093-inch thick aluminum with angle aluminum bracing at several points to increase the rigidity. The sides and curved surfaces of the ridges were 0.125-inch thick aluminum pieces welded together and sanded to finished contour. One-quarter inch thick aluminum pads were attached at several points along the opposite edges of the ridges for fastening to the horn structure. The final assembly weighed 47.5 pounds.

MEASURED CHARACTERISTICS
SHORT AXIAL LENGTH HORN (0.2 GHz - 2.0 GHz)

Radiation patterns recorded on the development model were found to be comparable to those of the original 6-inch axial length horn of Figure 1, which is a 1/5-scale version of the present design. Pattern deterioration begins above 1.8 GHz and becomes severe above 2.0 GHz. The VSWR was slightly higher and a little more oscillatory than on the scale model, but still well under 2:1 over most of the band. In an earlier development using this type of launcher, it was found that two small metal pins located as shown in Figure 37 were needed to suppress a very high VSWR (greater than 7:1) in the upper portion of the band, corresponding to a frequency of 1.76 GHz in the present model. The pins were not required to cover the original band from 0.2 GHz to 1.0 GHz. However, the pins were included in order to evaluate the performance of the horn over the full range available.

Because of the lack of good directive gain standards and the problem of severe ground reflections encountered at the lower frequencies, gain measurements were made on a scale model basis using the antenna of Figure 1. Some comparison gain measurements were made on the full scale model in the frequency range from 1 GHz to 2 GHz. These agreed to within 1 db or less in most cases where a comparison could be made, although the measurements were made in such different environments. The scale model measurements were recorded in an anechoic chamber where no attempt was made to account for residual reflections, and full scale measurements were made on an outdoor range where strong ground reflections had to be taken into account. The agreement was considered well within the accuracy required for the intended application. When it had been demonstrated that the design could be operated over the 0.2 GHz to 2.0 GHz frequency range, a change was made to include the entire band in the requirement. In addition a weight requirement of not more than 25 pounds was added. Since some H-plane patterns were too narrow in the upper portion of the band, the use of grid-type H-plane walls was again indicated as a means of maintaining the required beamwidth as well as being useful in meeting the weight requirement.

Since it was planned to again make scale model gain measurements, the 1/5-scale model was modified to include grid construction of the H-plane sides. That allowed determination of the electrical performance before going to a full scale model. The grid consisted of 0.093-inch aluminum rods spaced 1.228 inches apart. The modified scale model is shown in Figure 40. Measured performance characteristics of the new scale model met the requirements except for the H-plane patterns at 4.0 GHz, 6.0 GHz and 9.5 GHz which were slightly less than thirty degrees. Pattern deterioration again begins above 9.0 GHz and appears to be due to the onset of higher order modes.

Design and fabrication of a full scale model to meet the weight requirement was then undertaken and resulted in the configuration shown in Figure 41. Unfortunately, a reference scale was not included in the photograph so size is difficult to estimate. However, a good point of reference is the input coaxial connector which is identical with that shown on the 1/5-scale model of Figure 40. The launcher was fabricated of 0.093-inch thick aluminum sheet with aluminum angles added to increase rigidity. The E-plane sides were made of 0.032-inch thick aluminum reinforced with aluminum angles riveted along lines which intersect the center lines of the H-plane grid elements. The ends of the angles were drilled to accommodate the ends of the grid elements which were made of 0.500-inch aluminum tubing. Tack welds at the junctions of the angles and grid elements complete the horn structure. Similarly, the weight of the ridges was reduced by using much thinner materials. Most of the details can be seen by referring to the view shown in Figure 41. The weight of the final development model was 21.25 pounds. The grid elements nearest the launcher on each side of the horn were not required electrically but were included to support the corners of the E-plane sides. Figure 42 is another view of the horn, and also shows the comparative size of the scale model.

Figures 43 through 62 are typical E- and H-plane patterns plotted on a relative voltage scale. The performance is as expected based on the scale model measurements. The narrow H-plane patterns occur at the full scale frequencies of 0.8 GHz, 1.2 GHz, and 1.9 GHz (not shown) and pattern deterioration begins above 1.8 GHz. Figure 63 shows the VSWR and gain curves with the gain curve again based on scale model measurements. The sharp drop-off in gain at the high end of the band is attributed to the onset of higher order modes and pattern deterioration as discussed earlier.

CONCLUSIONS

Two very broadband horns, with a substantially reduced axial length, have been designed to cover the 0.2 GHz to 12.0 GHz in two overlapping bands. Except for some minor instances in the case of the 0.2 GHz to 2.0 GHz model, the original requirements have been met. It has been indicated by the user that the performance of the two models far surpasses that of the antennas previously used in the type of RFI measurements for which the horn development program was undertaken. Generally speaking, the measured performance characteristics of the 1 GHz to 12 GHz design are superior to those of the 0.2 GHz to 2.0 GHz model. If required, the bandwidth of the lower frequency model can be increased and performance improved by changing the launcher portion to a scaled version of the launcher described for the 1 GHz to 12 GHz model.

Based on the data obtained during the development of the two short axial length horns, it now appears likely that the axial length can be further shortened. That reduction, if successful, could lead to maintaining wider beamwidths than is now the case and could provide a meaningful reduction in the overall length of the lower frequency horn.

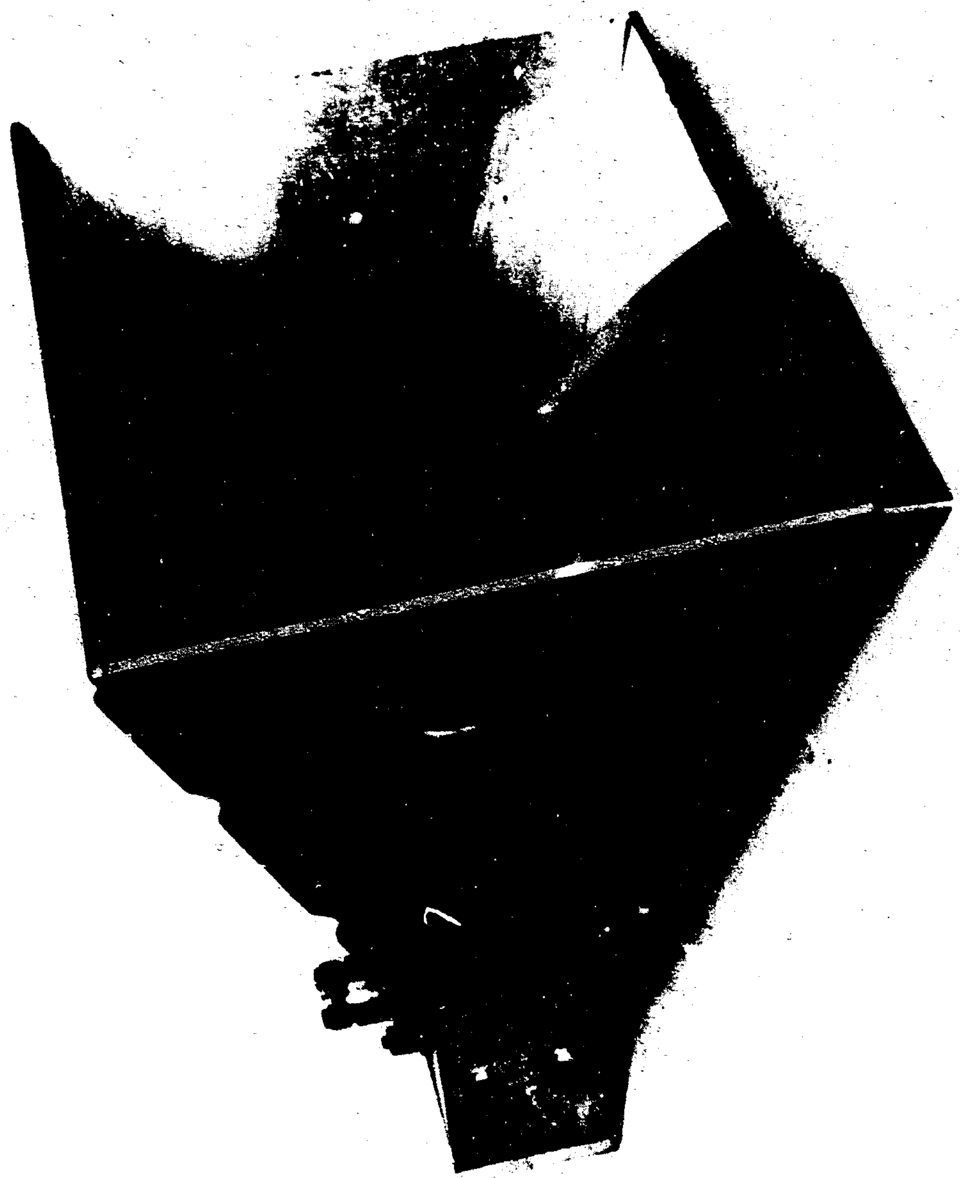


FIGURE 1 - 6-INCH AXIAL LENGTH HORN

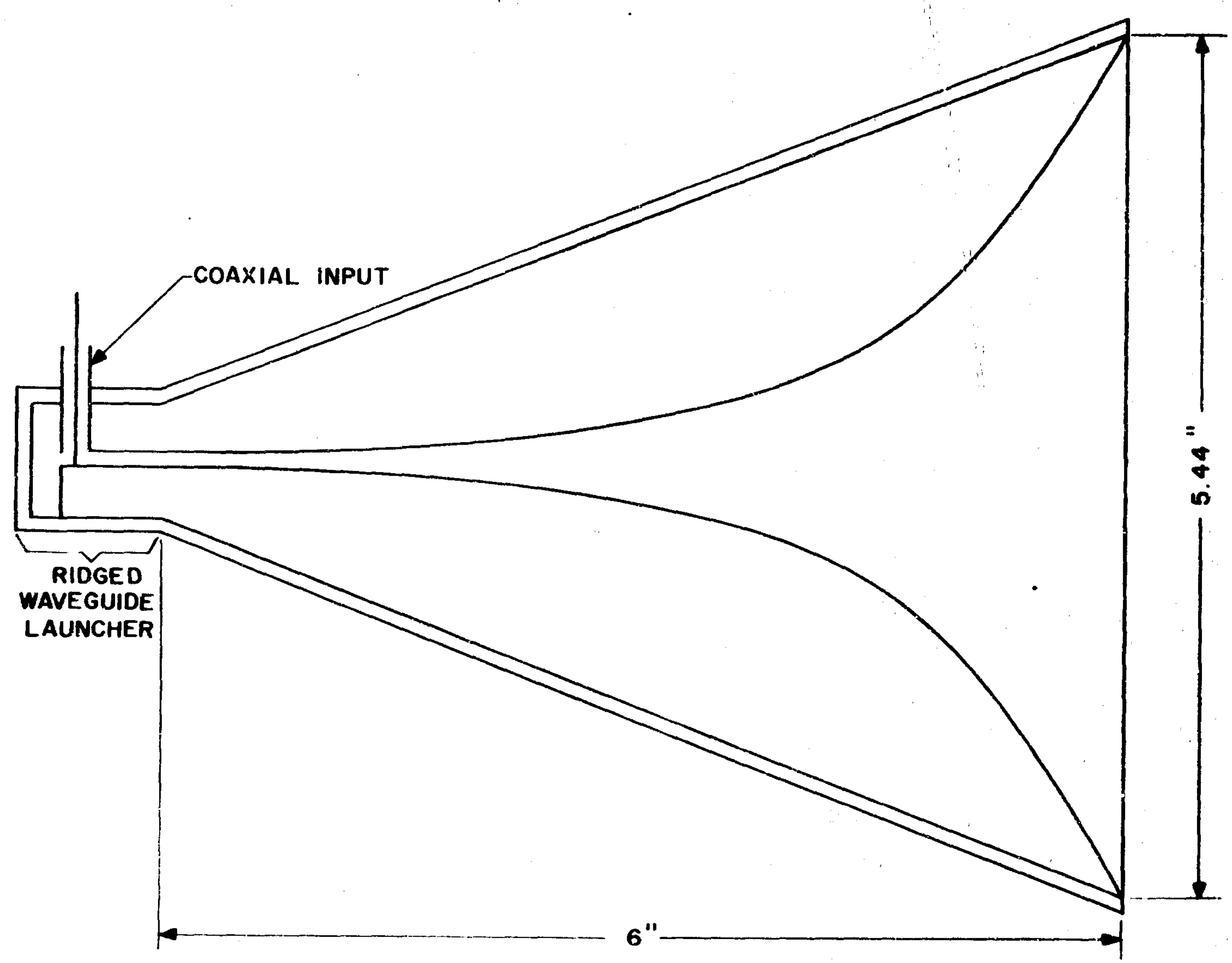
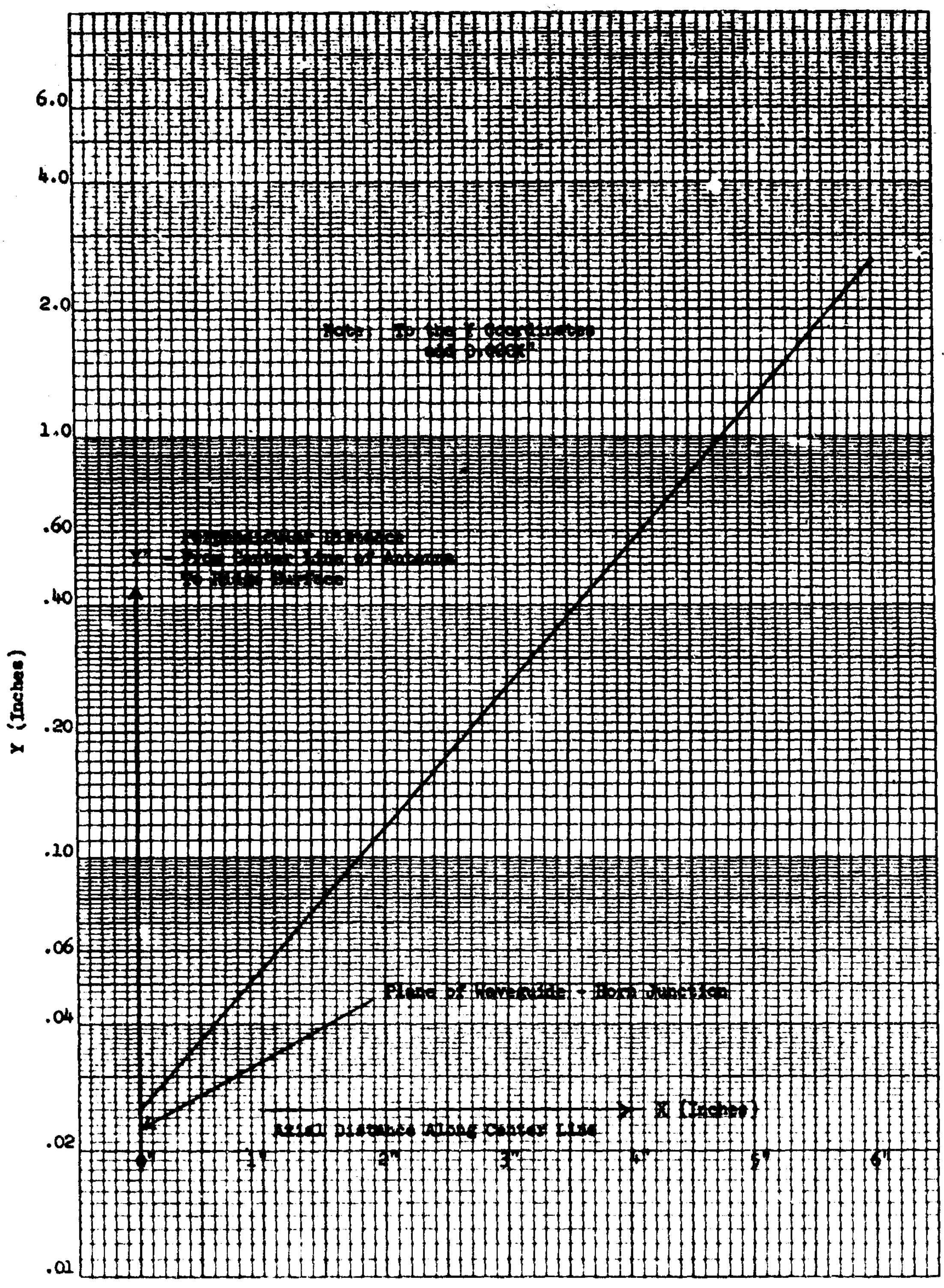
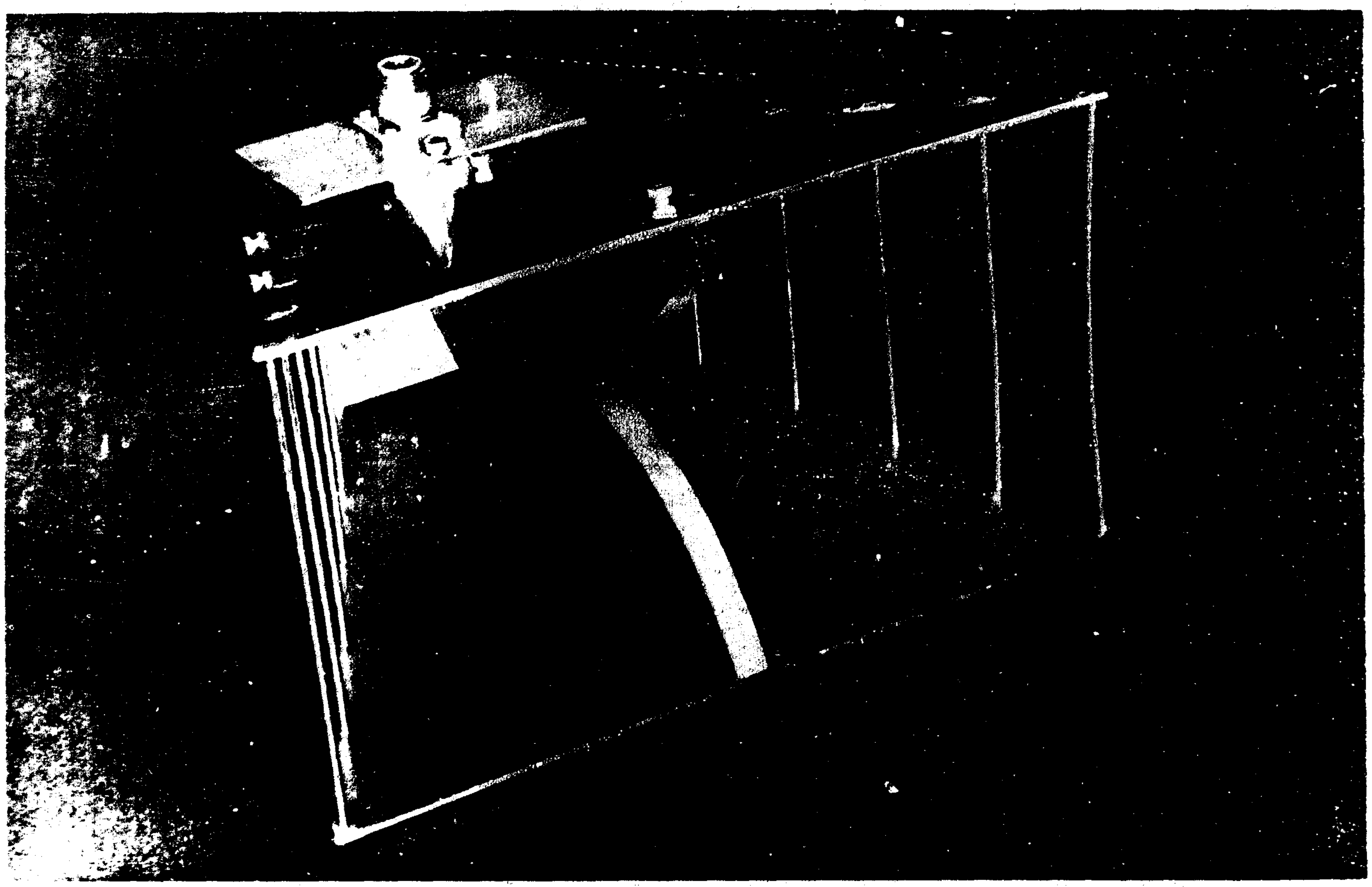


FIGURE 2 - SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)



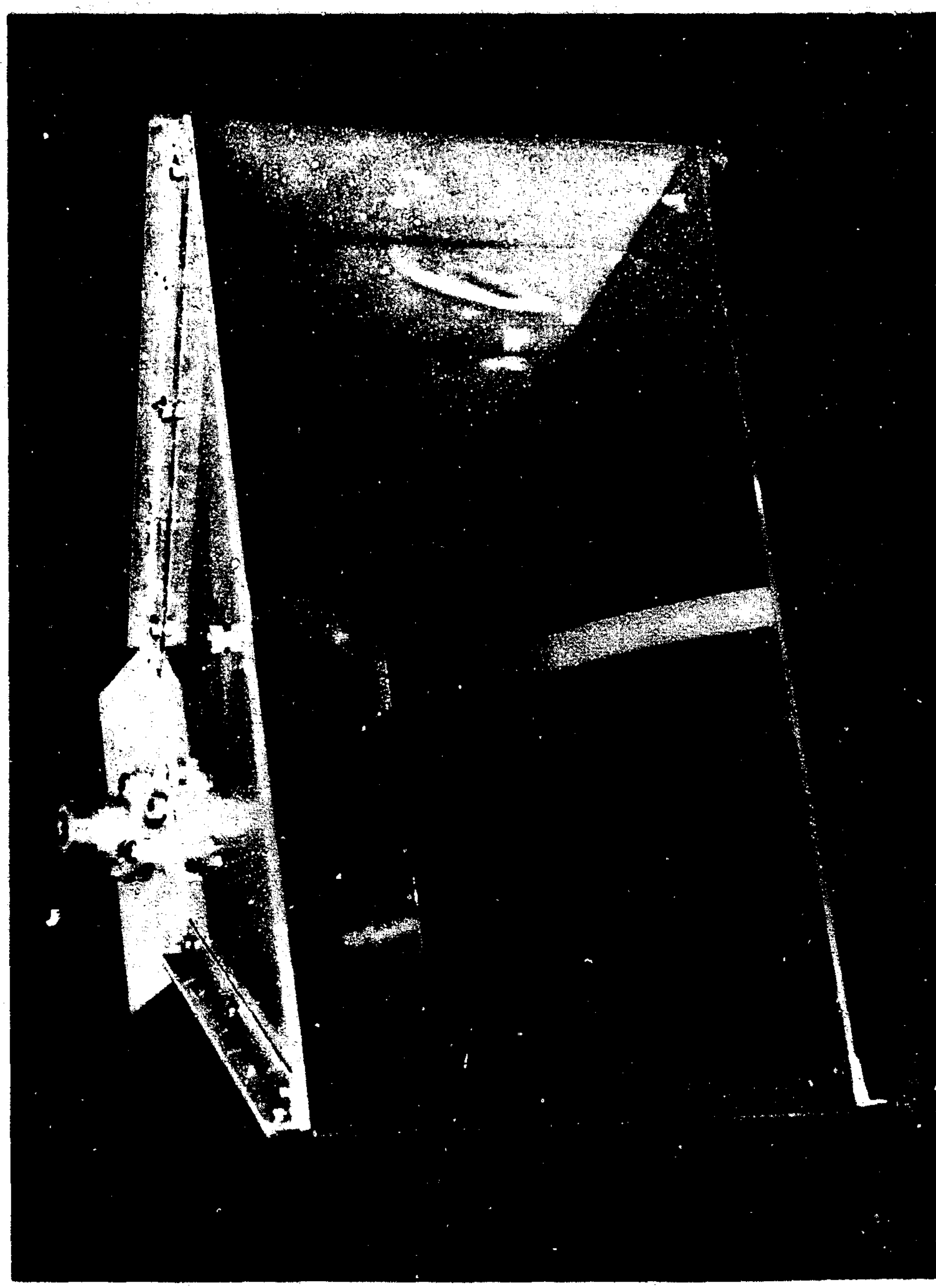
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 3 - RIDGE CURVE COORDINATES



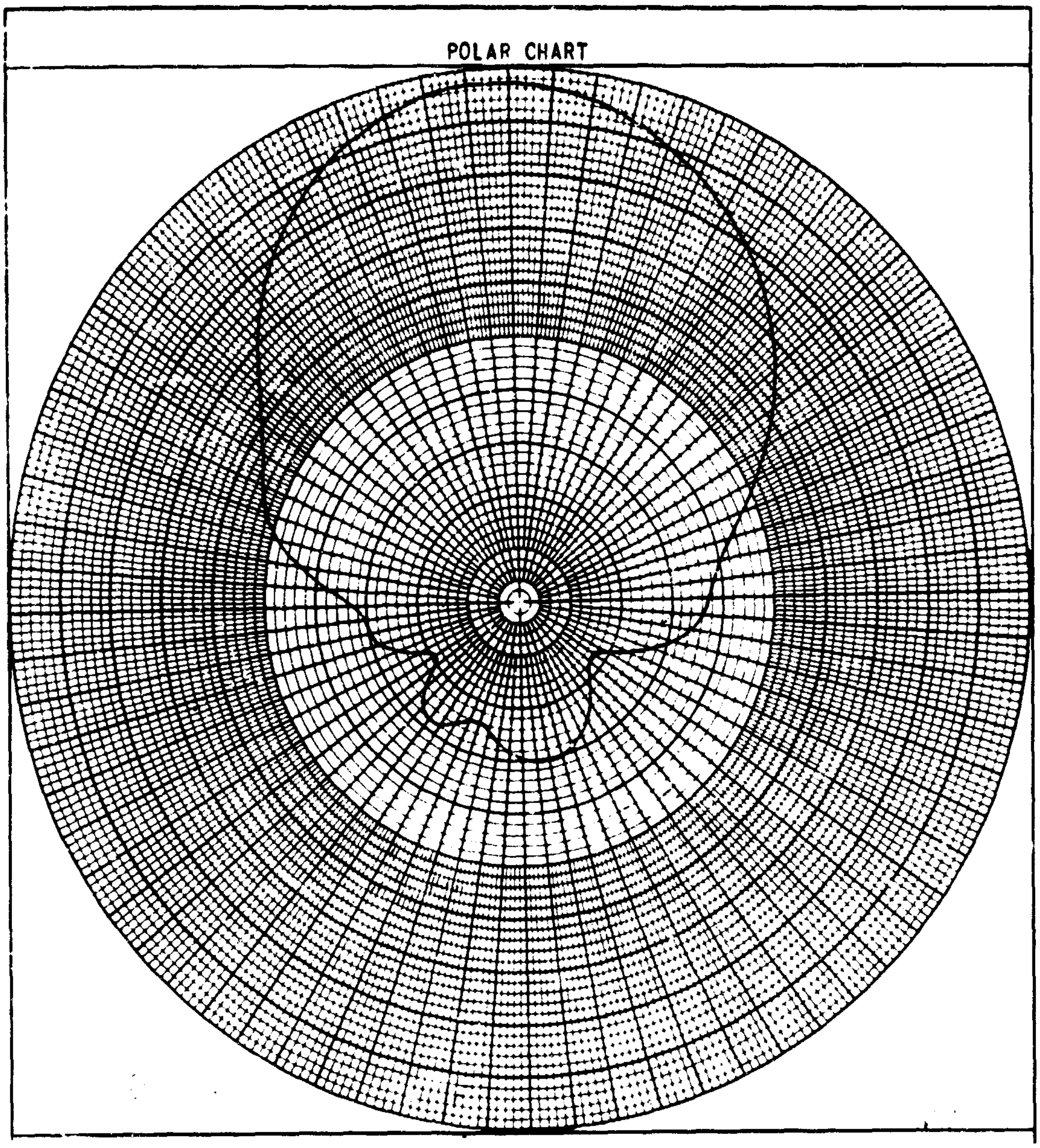
SHORT AXIAL LENGTH HORN (1 GHz-12 GHz)

FIGURE 4-GRID CONSTRUCTION (H-PLANE SIDES)



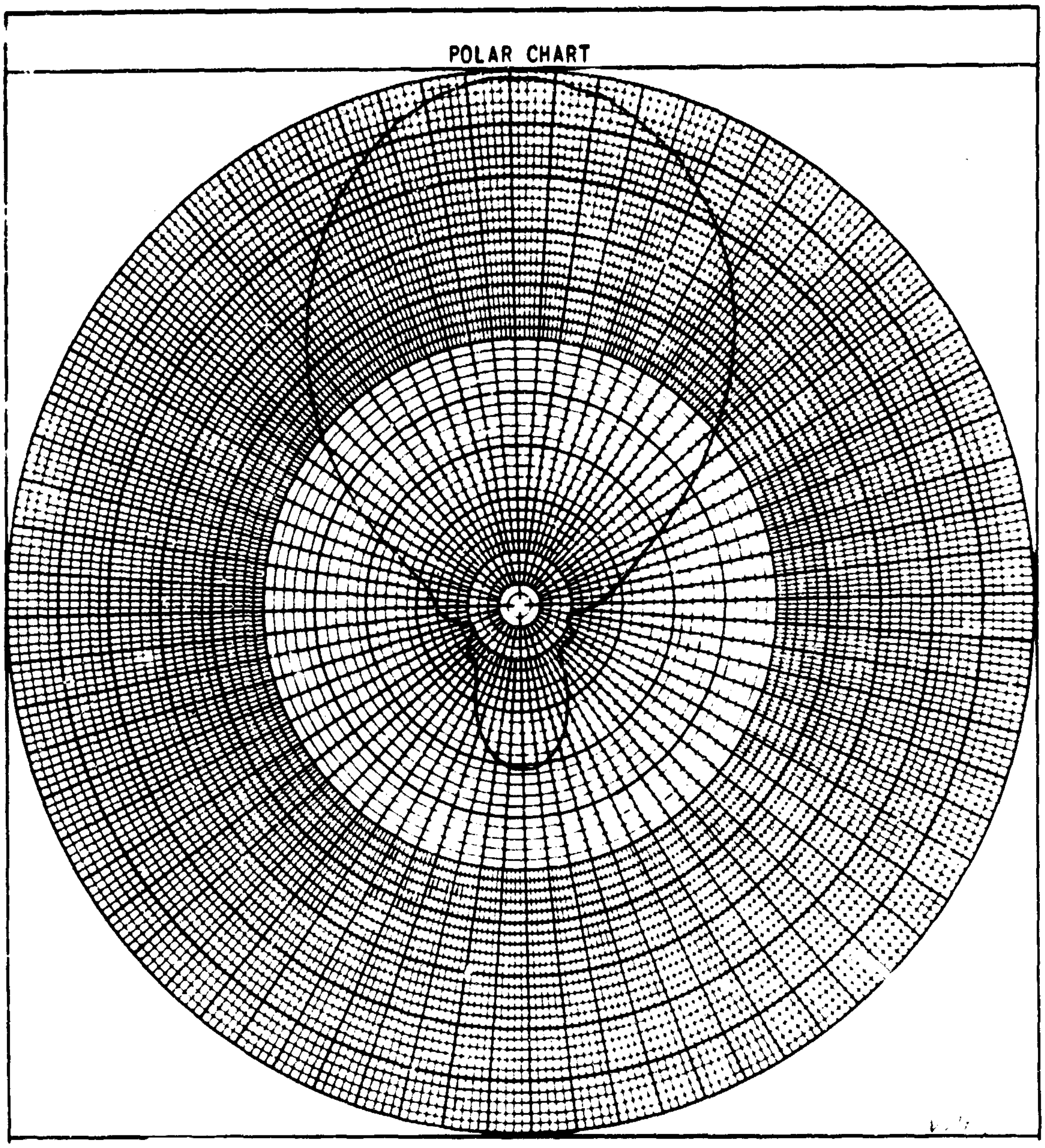
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 5-PRINTED CIRCUIT GRID CONSTRUCTION



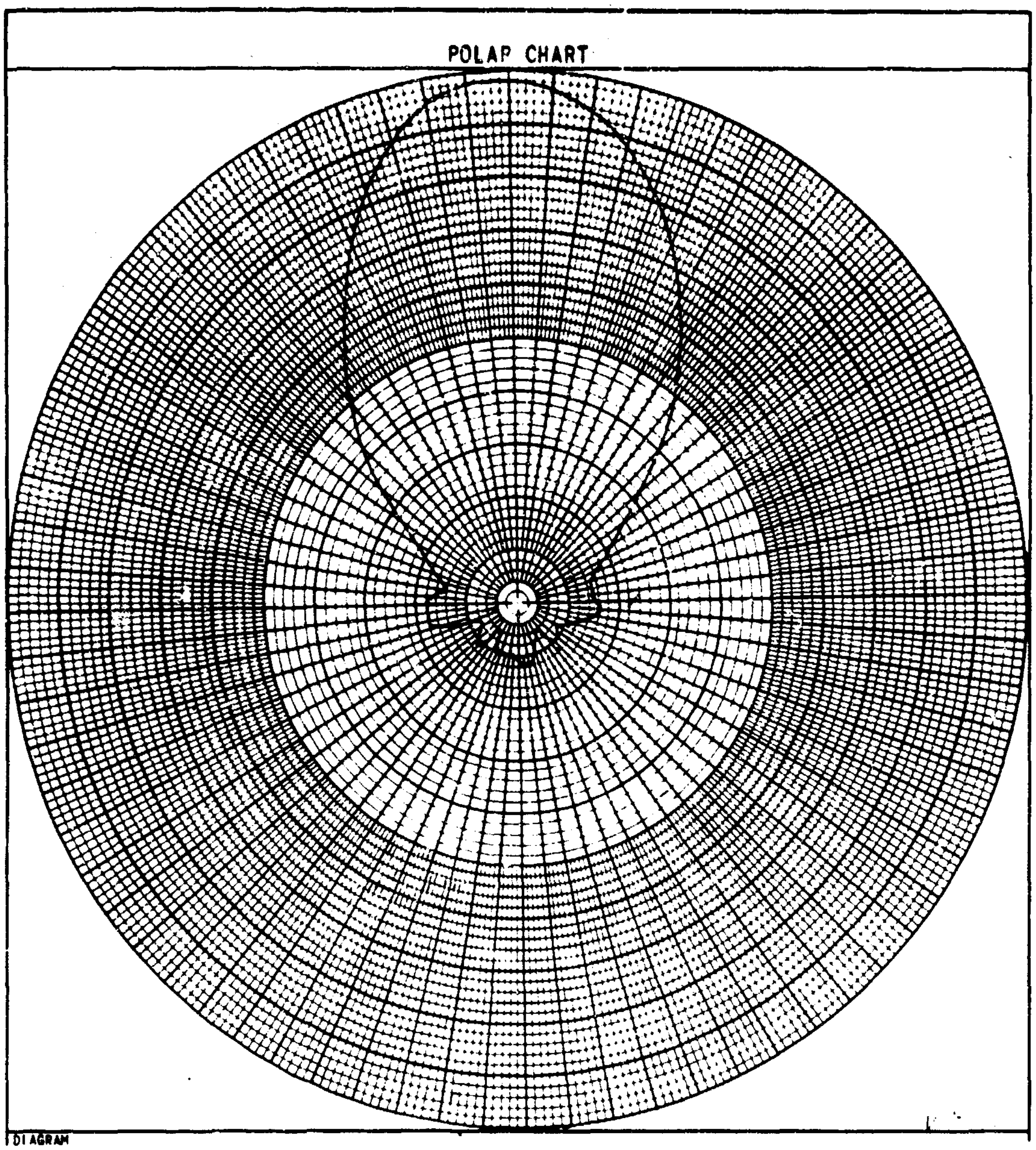
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 6 1.0 GHz E-PLANE



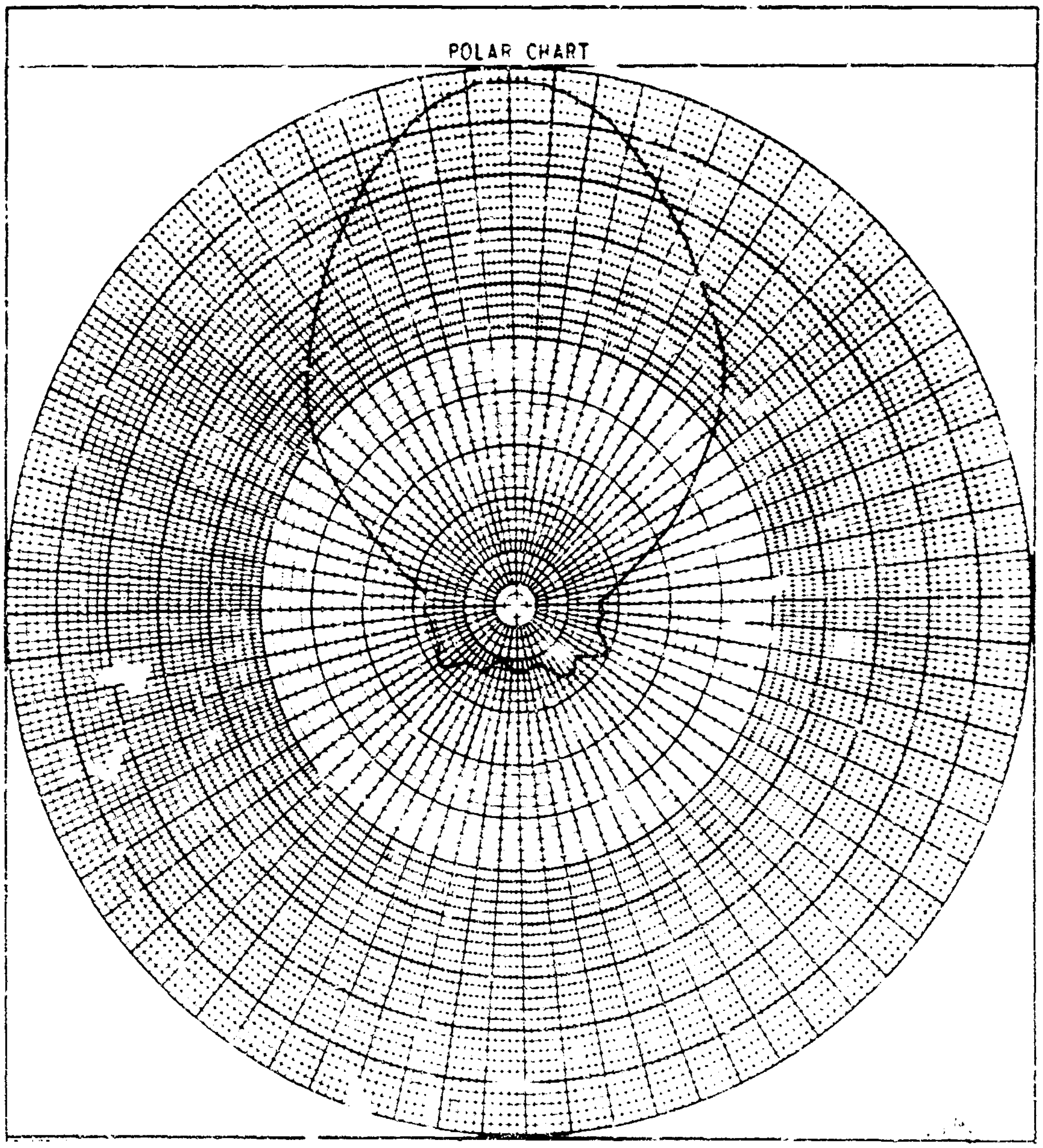
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 7 1.0 GHz H-PLANE



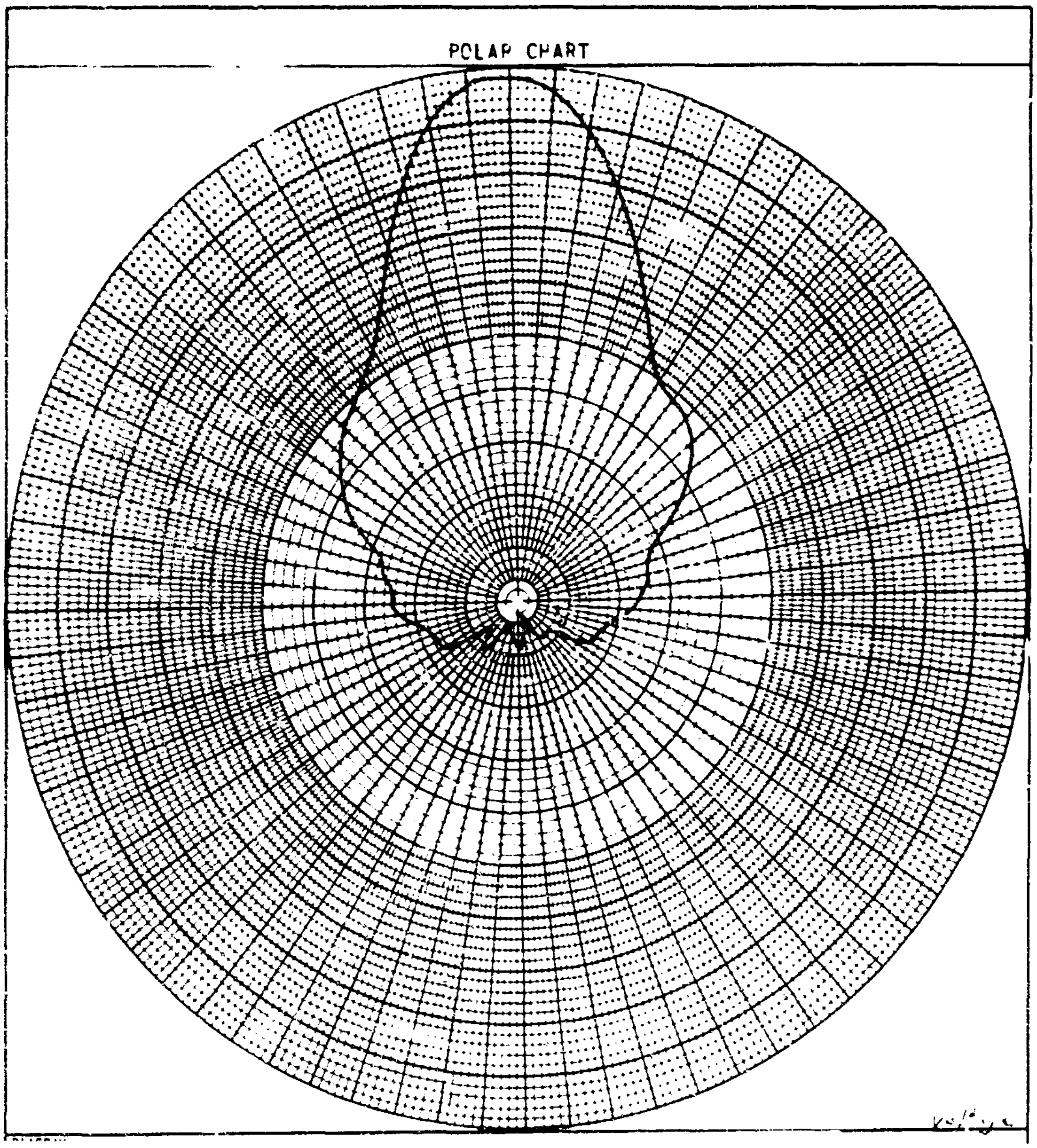
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 8 2.0 GHz E-PLANE



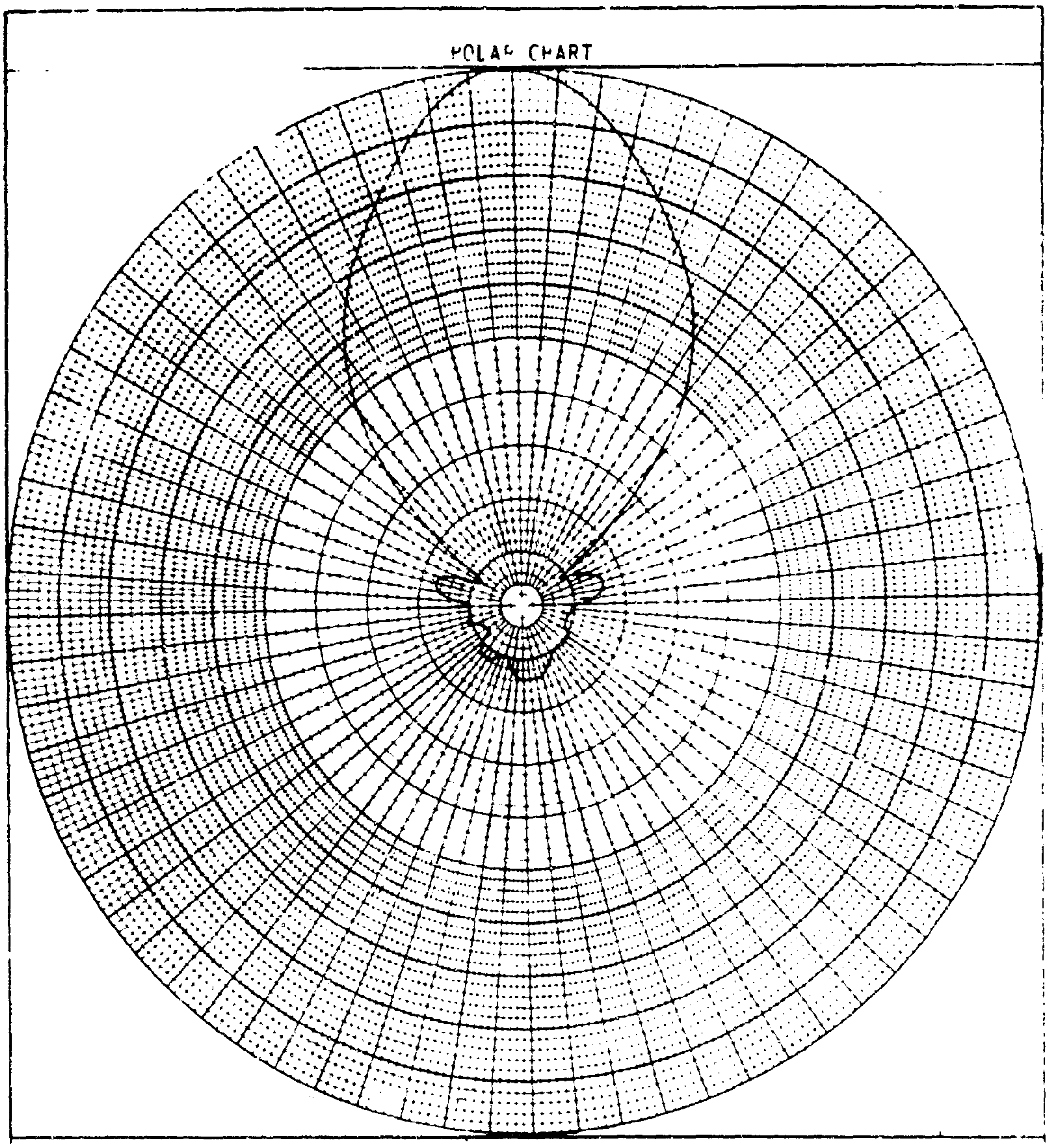
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 9 2.0 GHz H-PLANE



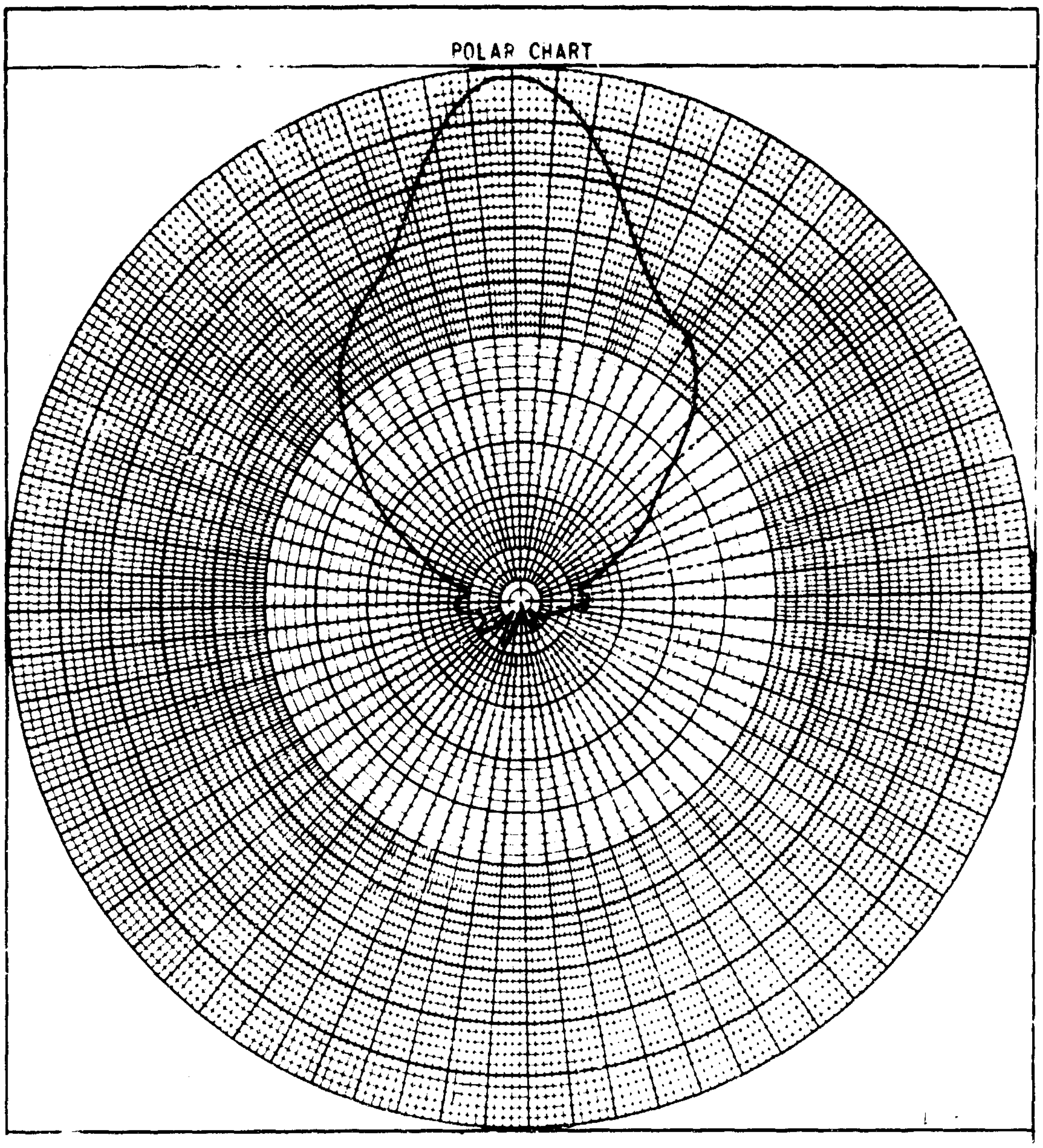
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 10 3.0 GHz E-PLANE



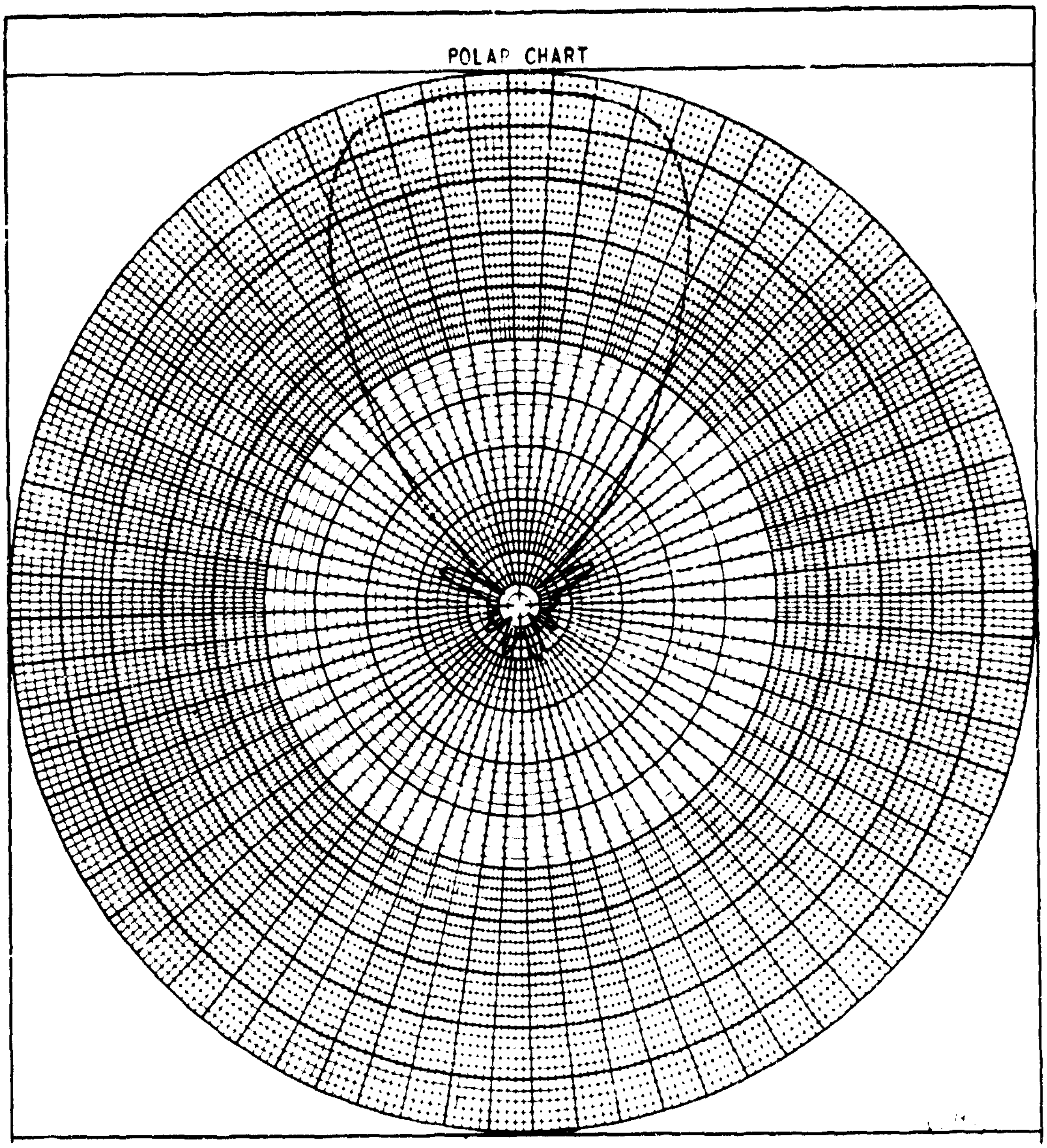
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 11 3.0 GHz H-PLANE



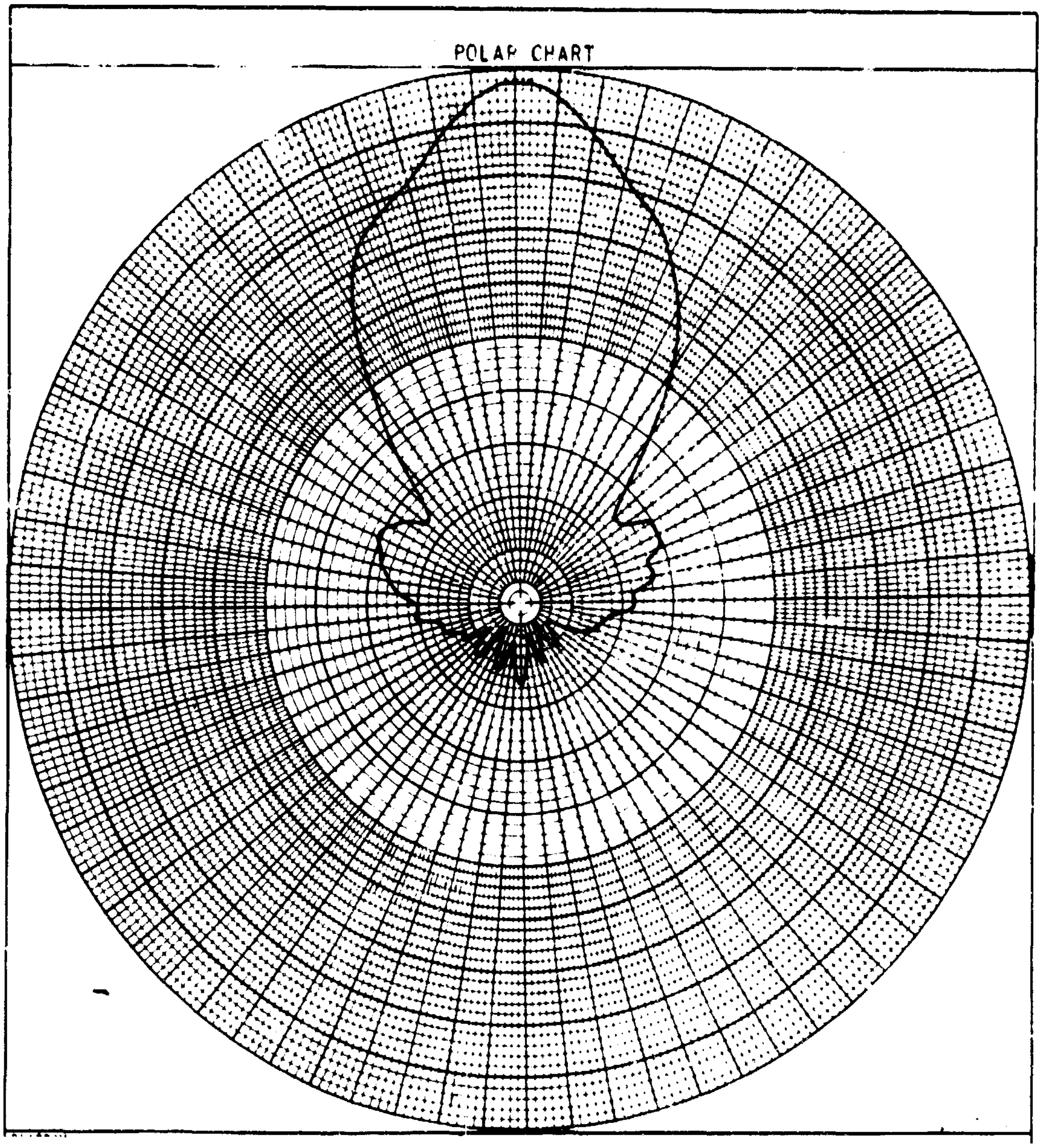
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 12 4.0 GHz E-PLANE



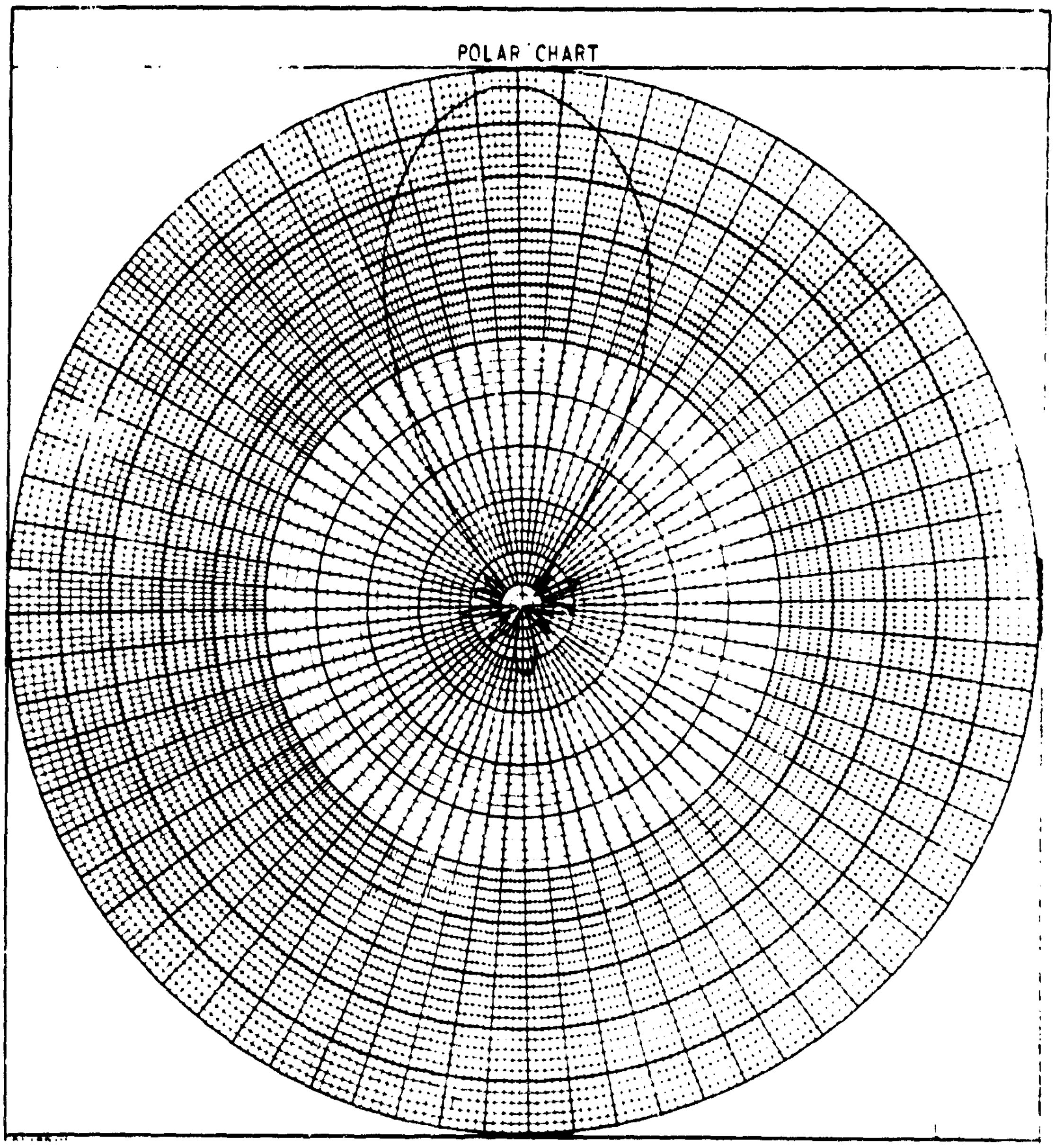
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 13 4.0 GHz H-PLANE



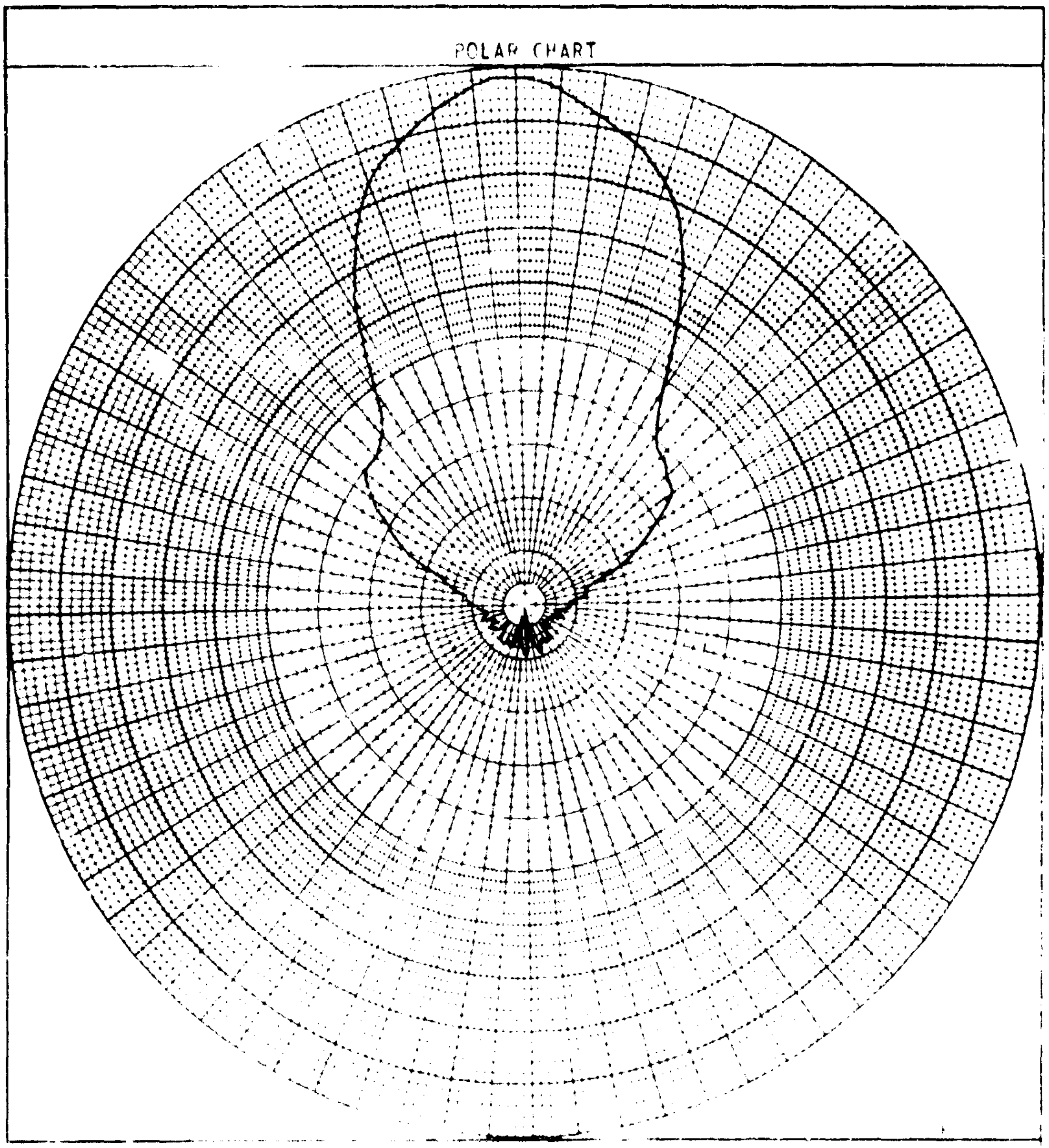
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 14 5.0 GHz E-PLANE



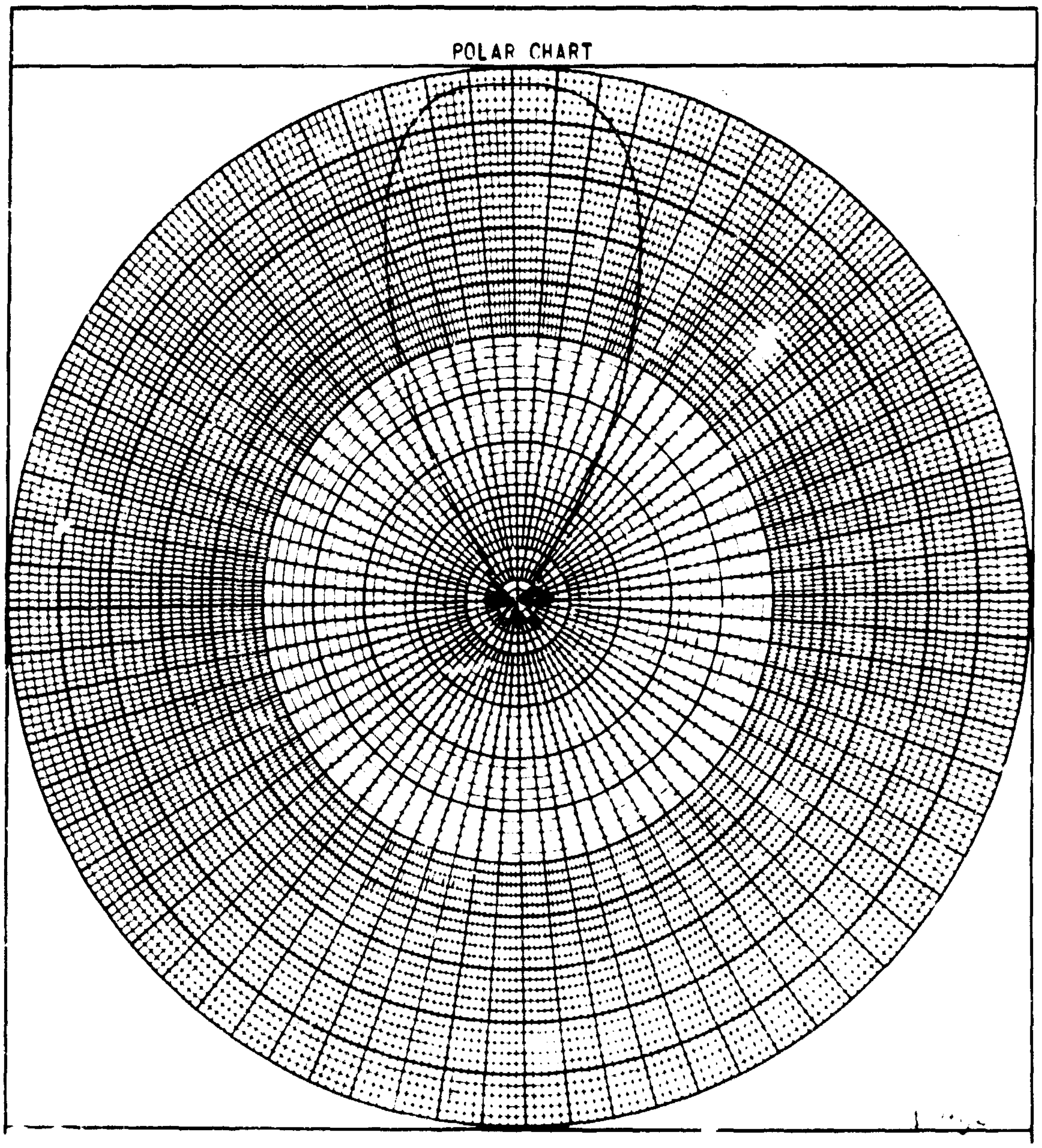
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 15 5.0 GHz H-PLANE



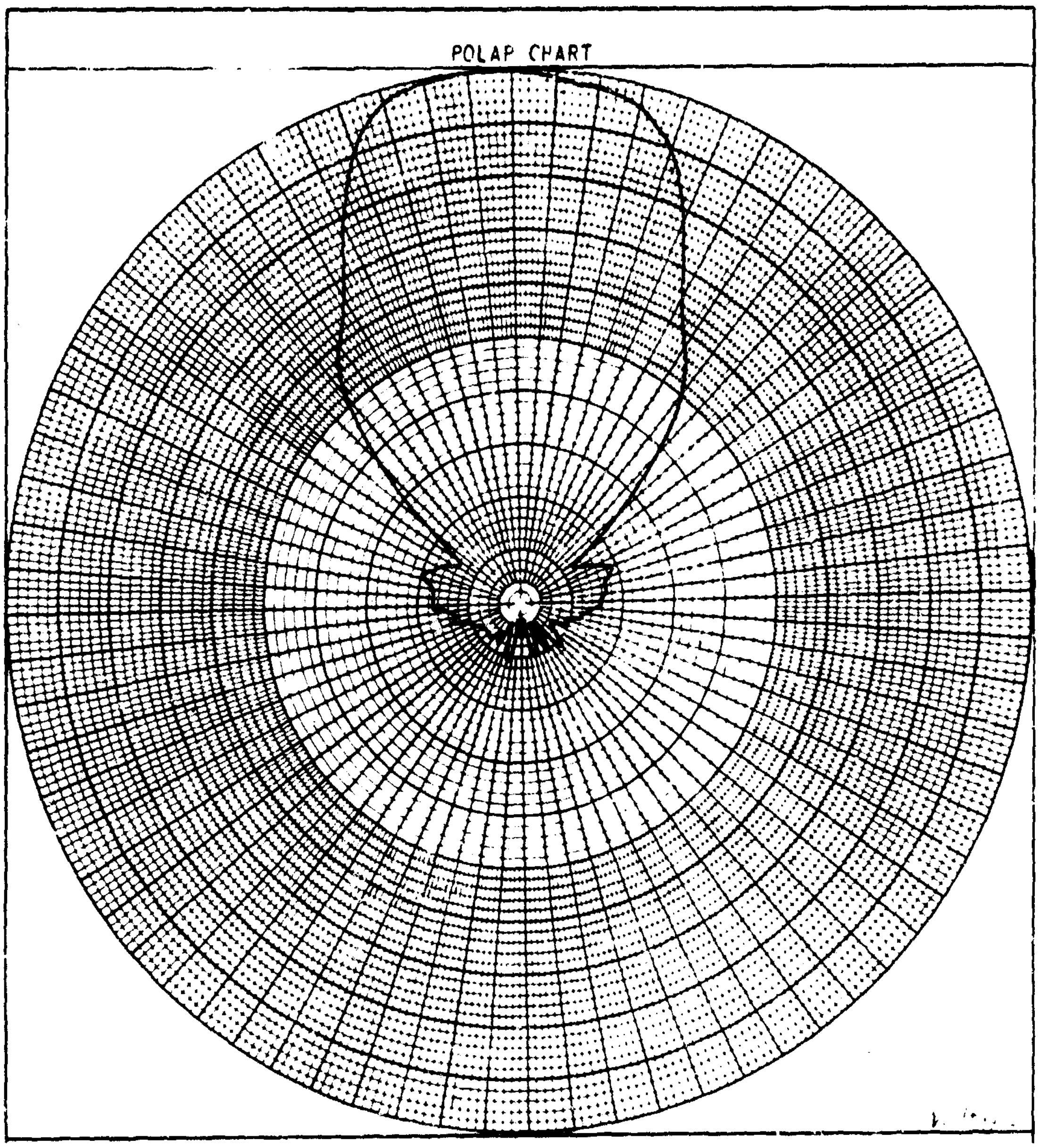
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE [illegible] [illegible] GHz E-PLANE



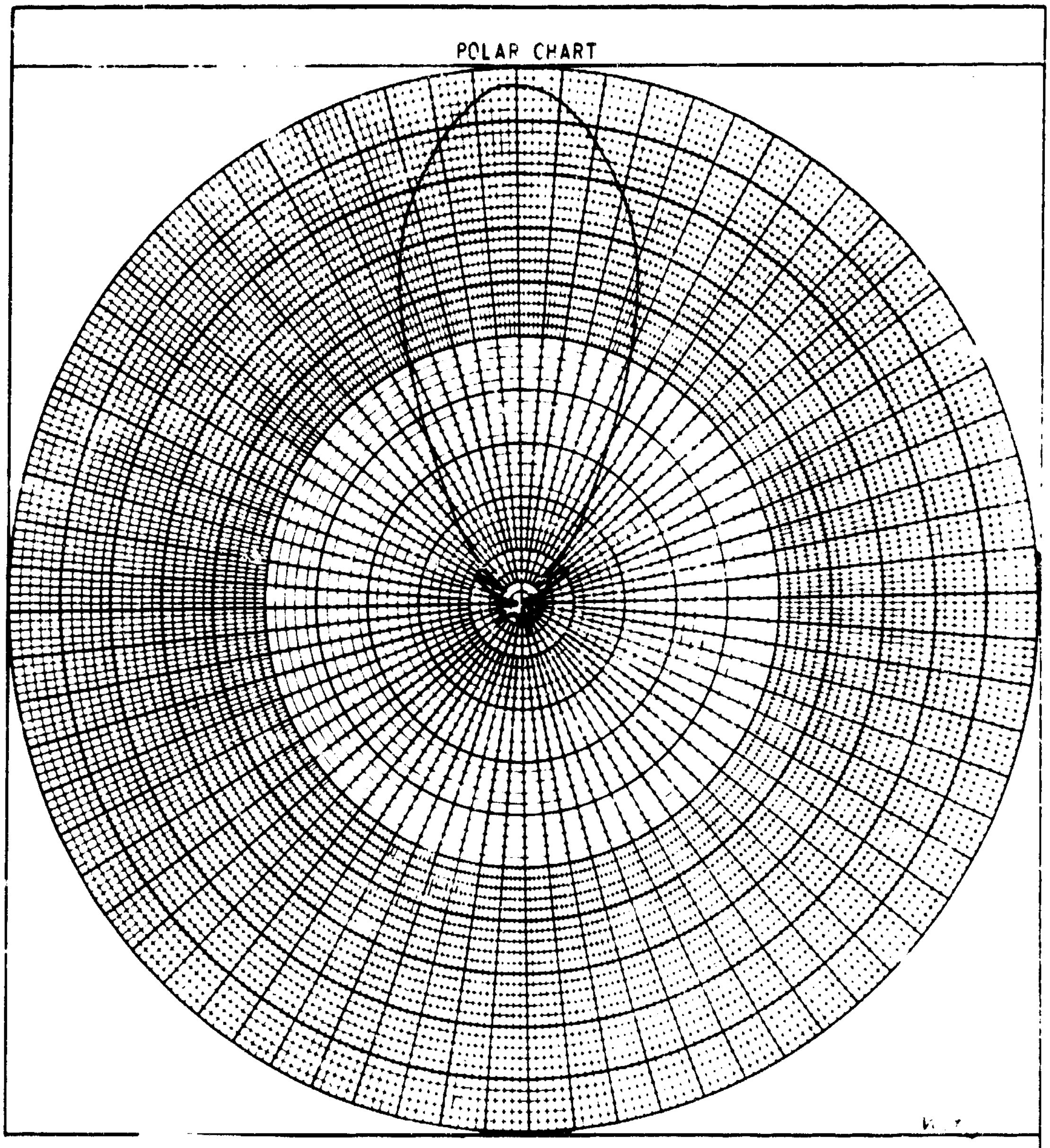
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 17 6.0 GHz H-PLANE



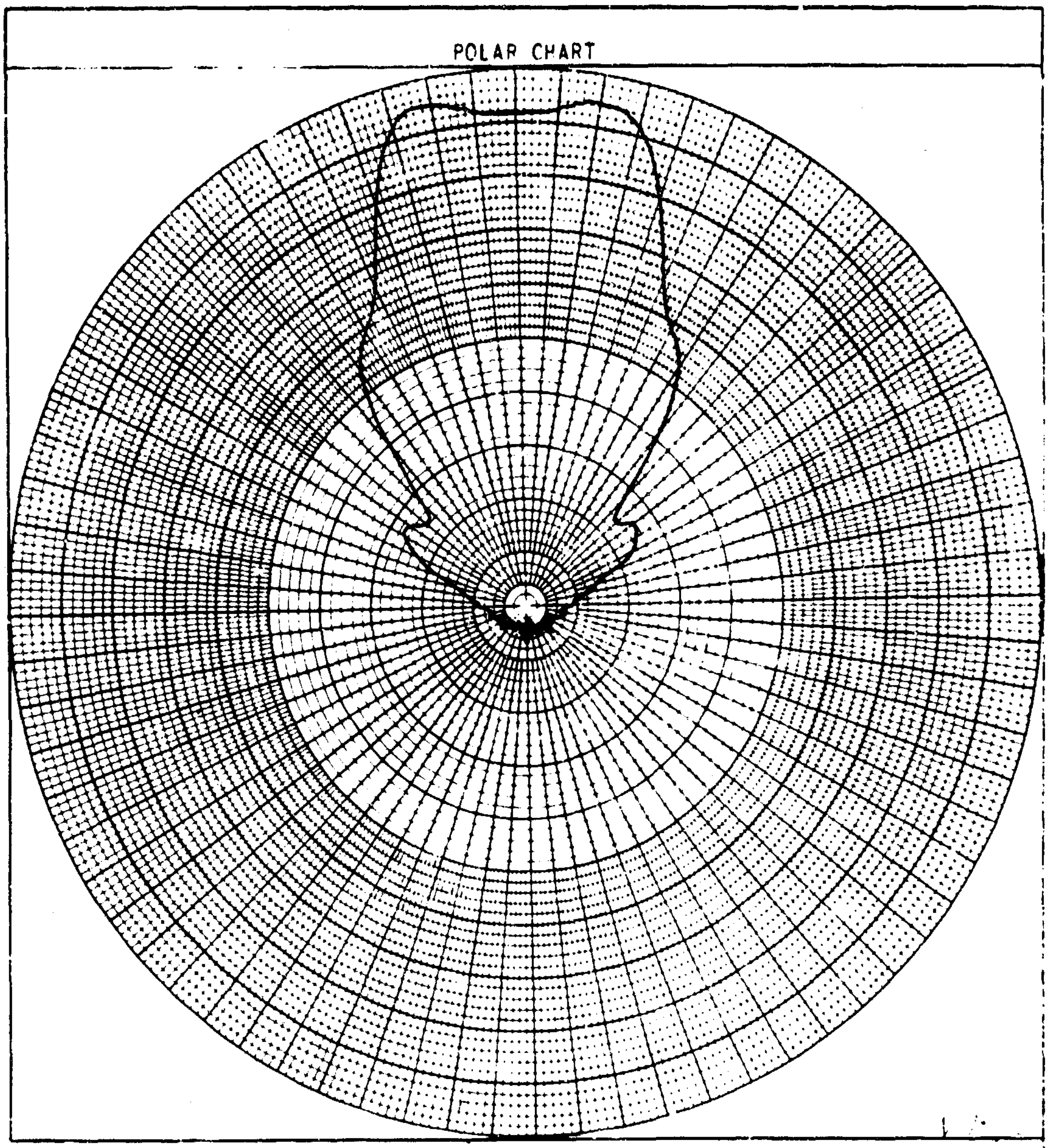
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 18 7.0 GHz E-PLANE



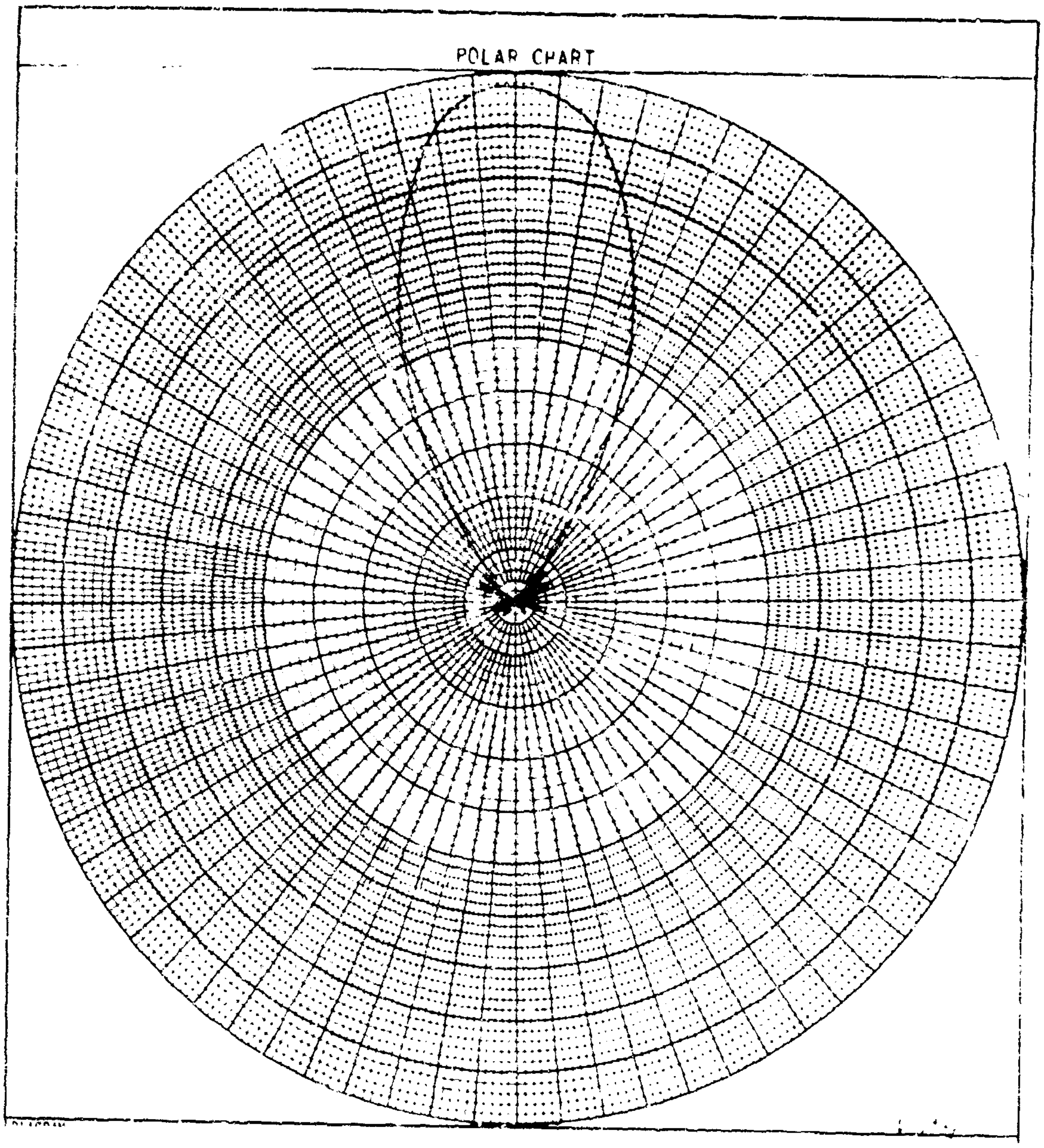
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 19 7.0 GHz H-PLANE



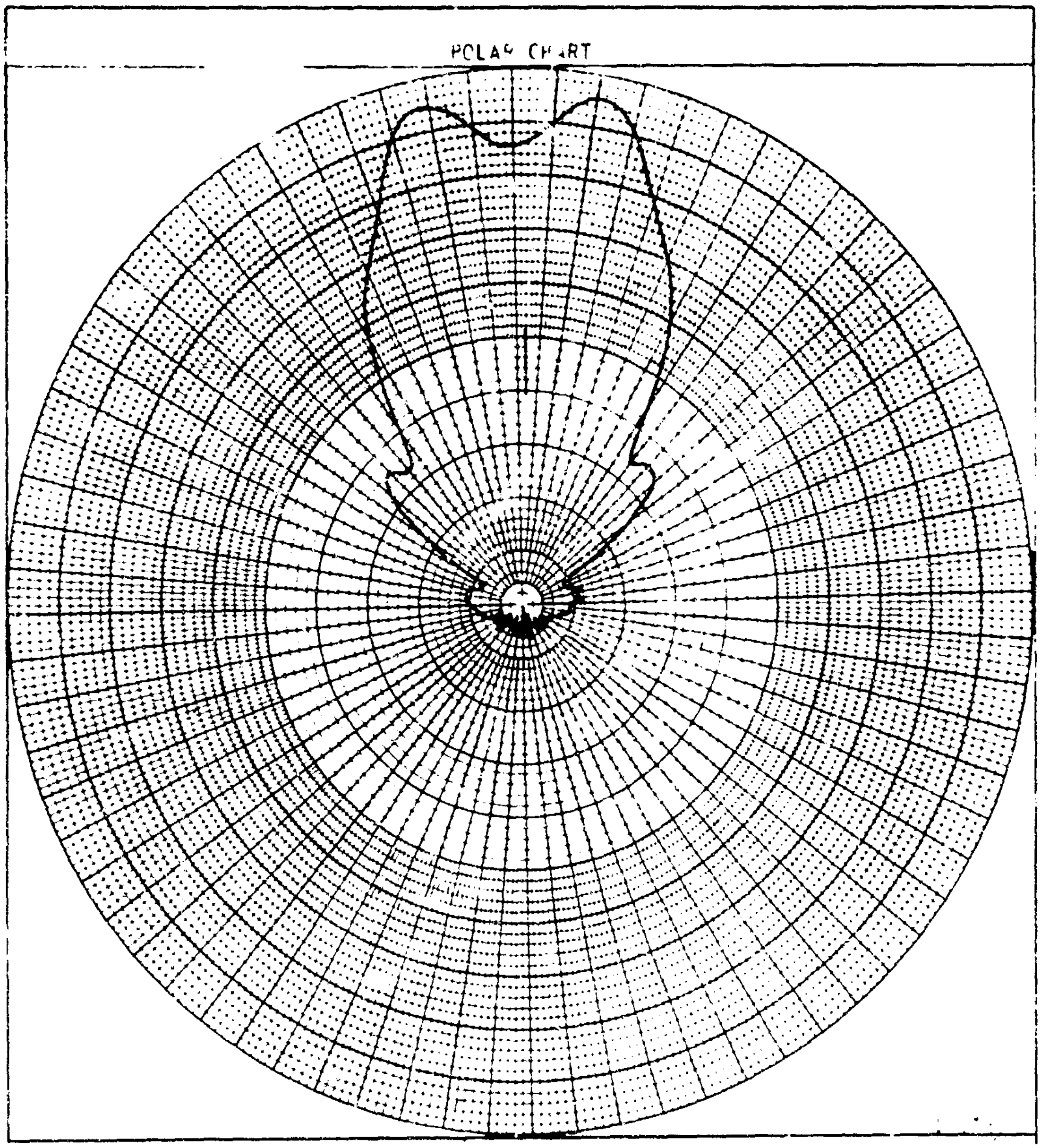
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 20 8.0 GHz E-PLANE



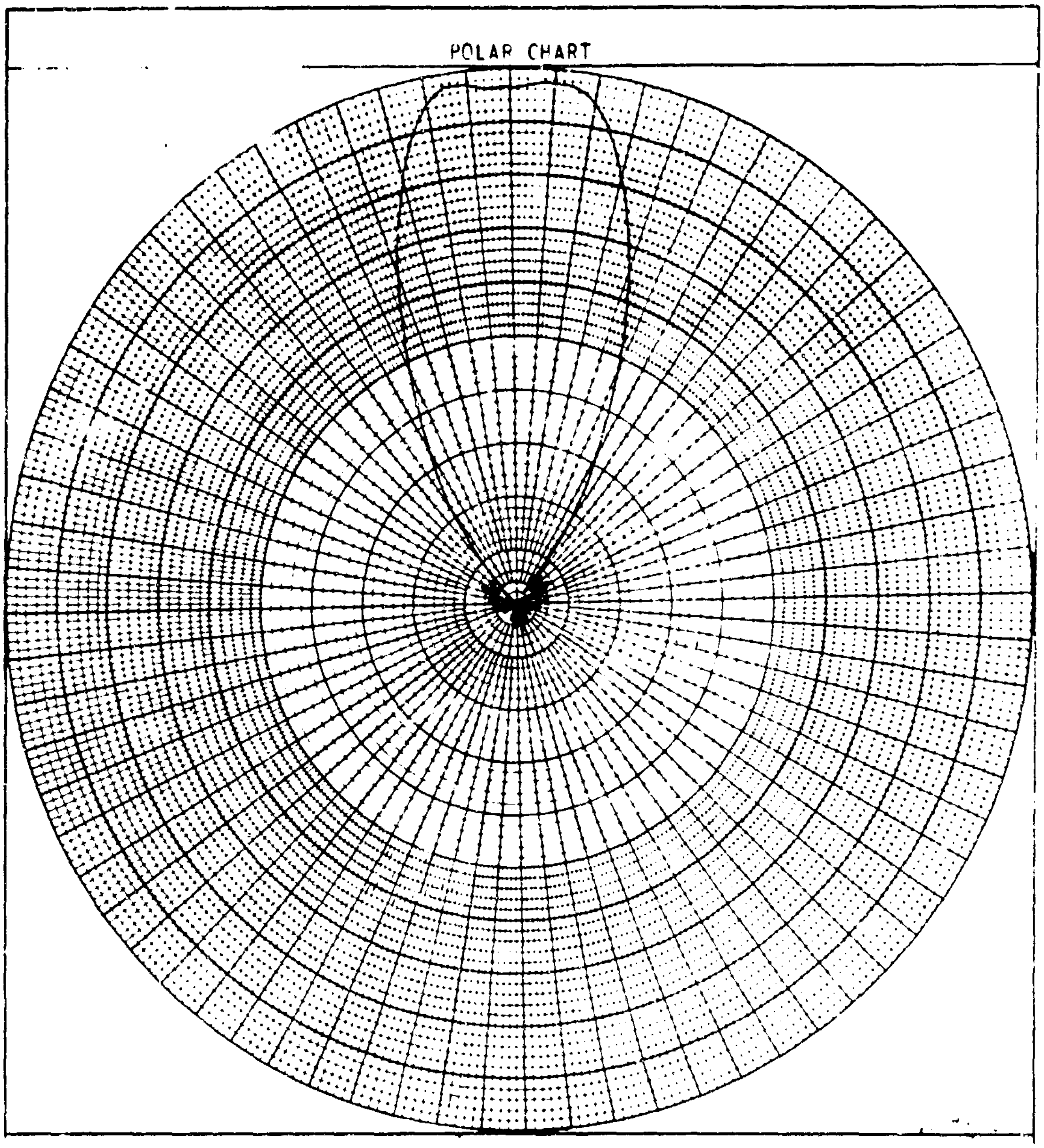
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 21 8.0 GHz H-PLANE



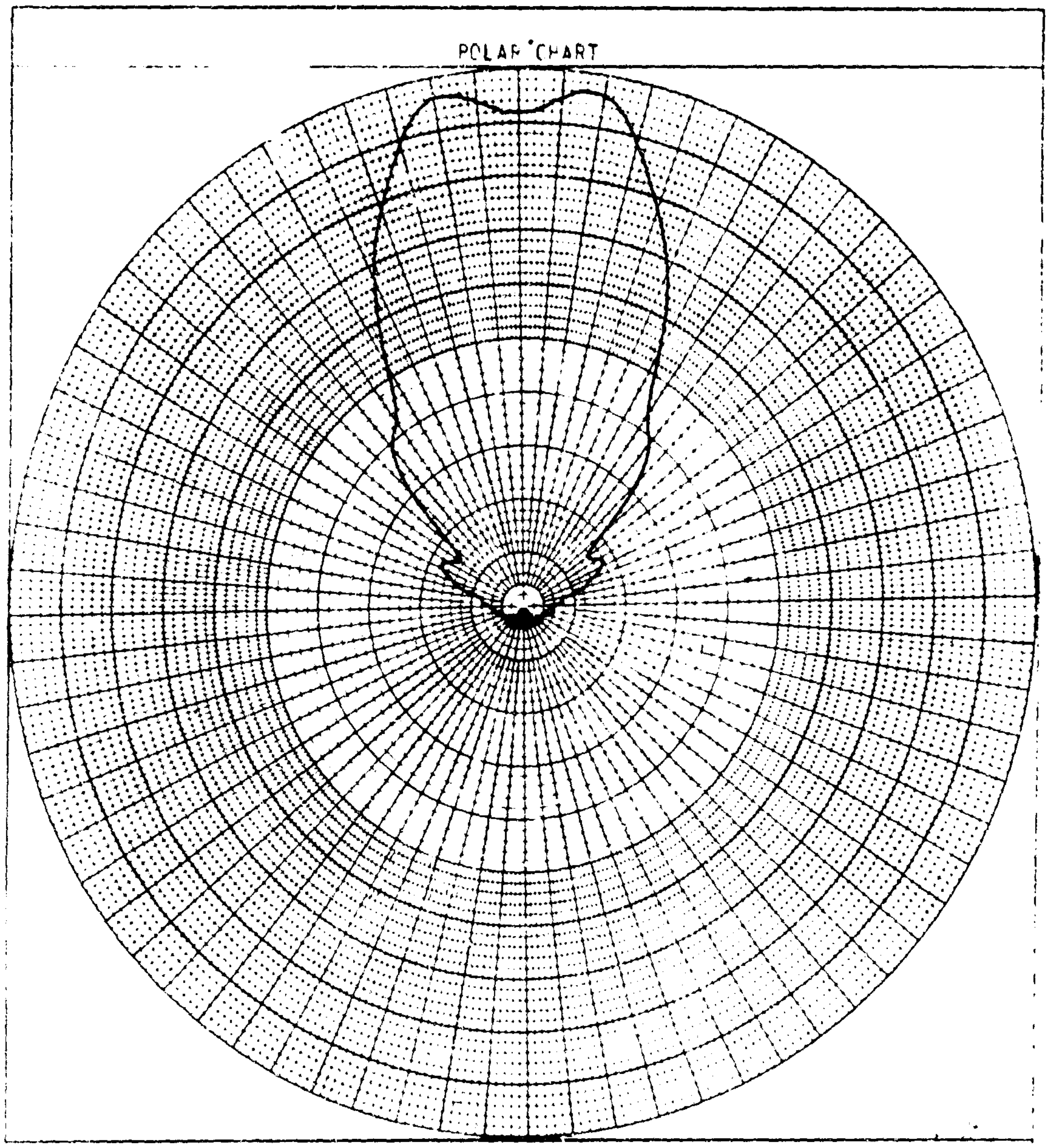
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 22 9.0 GHz E-PLANE



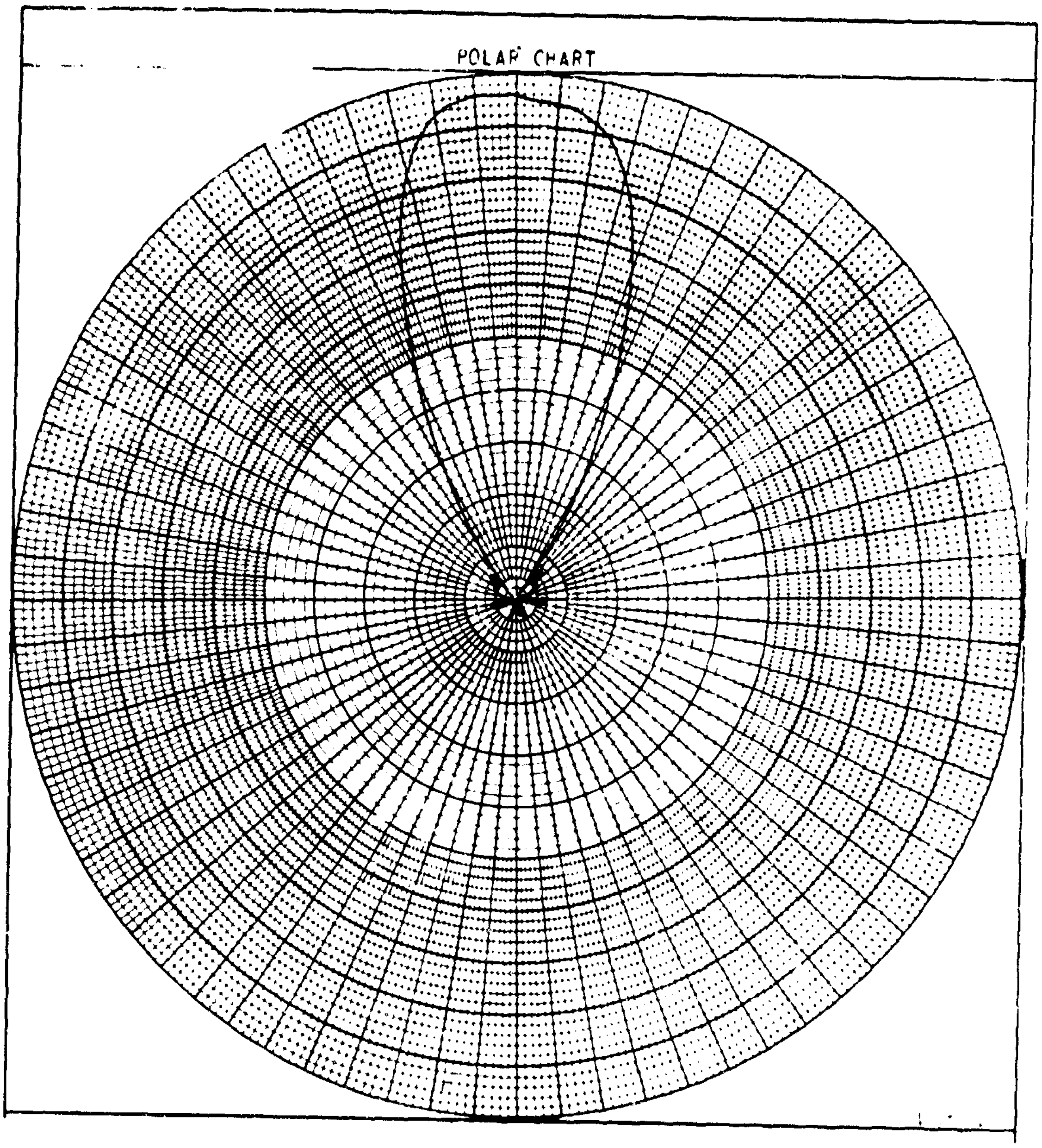
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 23 9.0 GHz H-PLANE



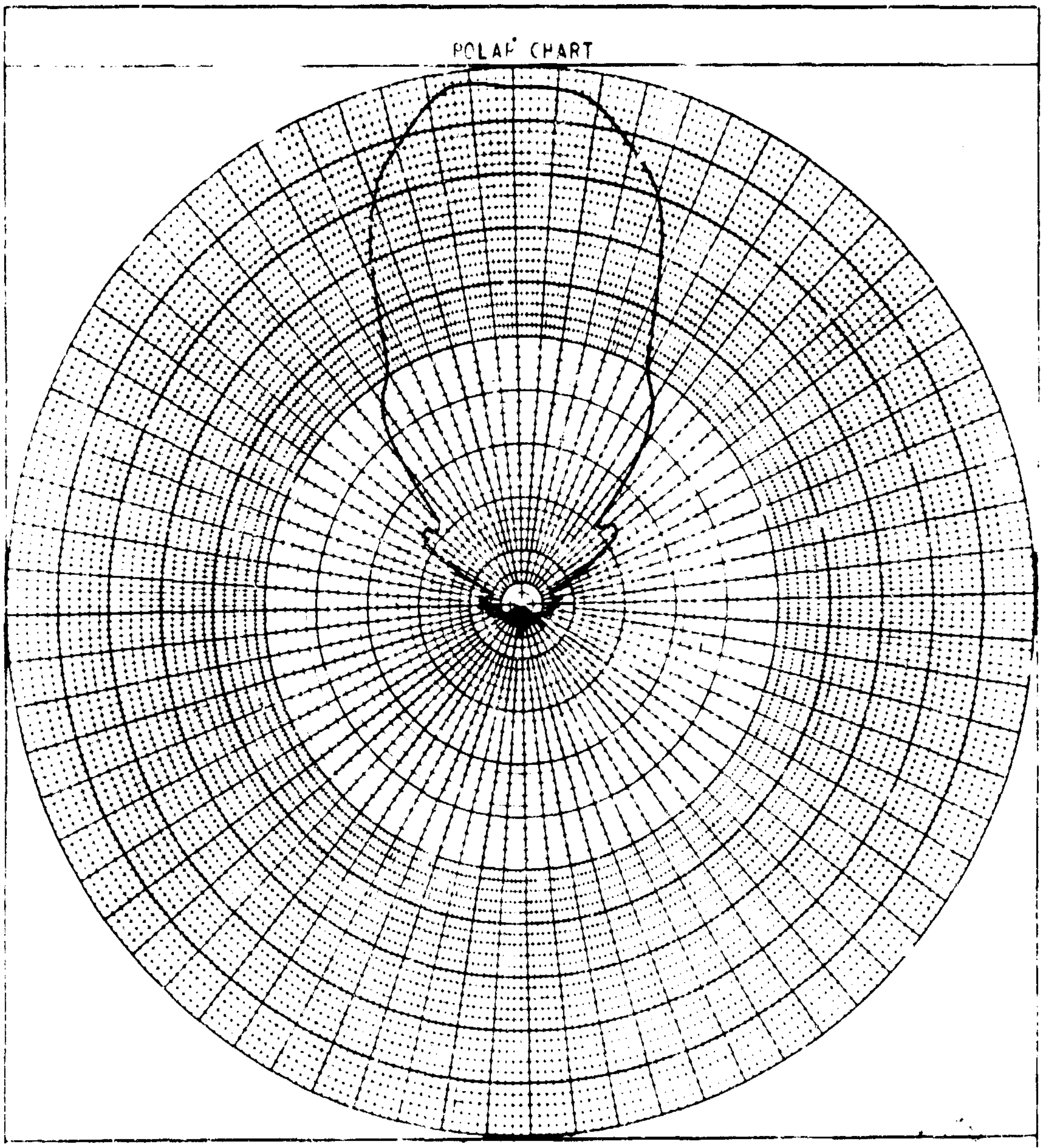
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 24 10.0 GHz E-PLANE



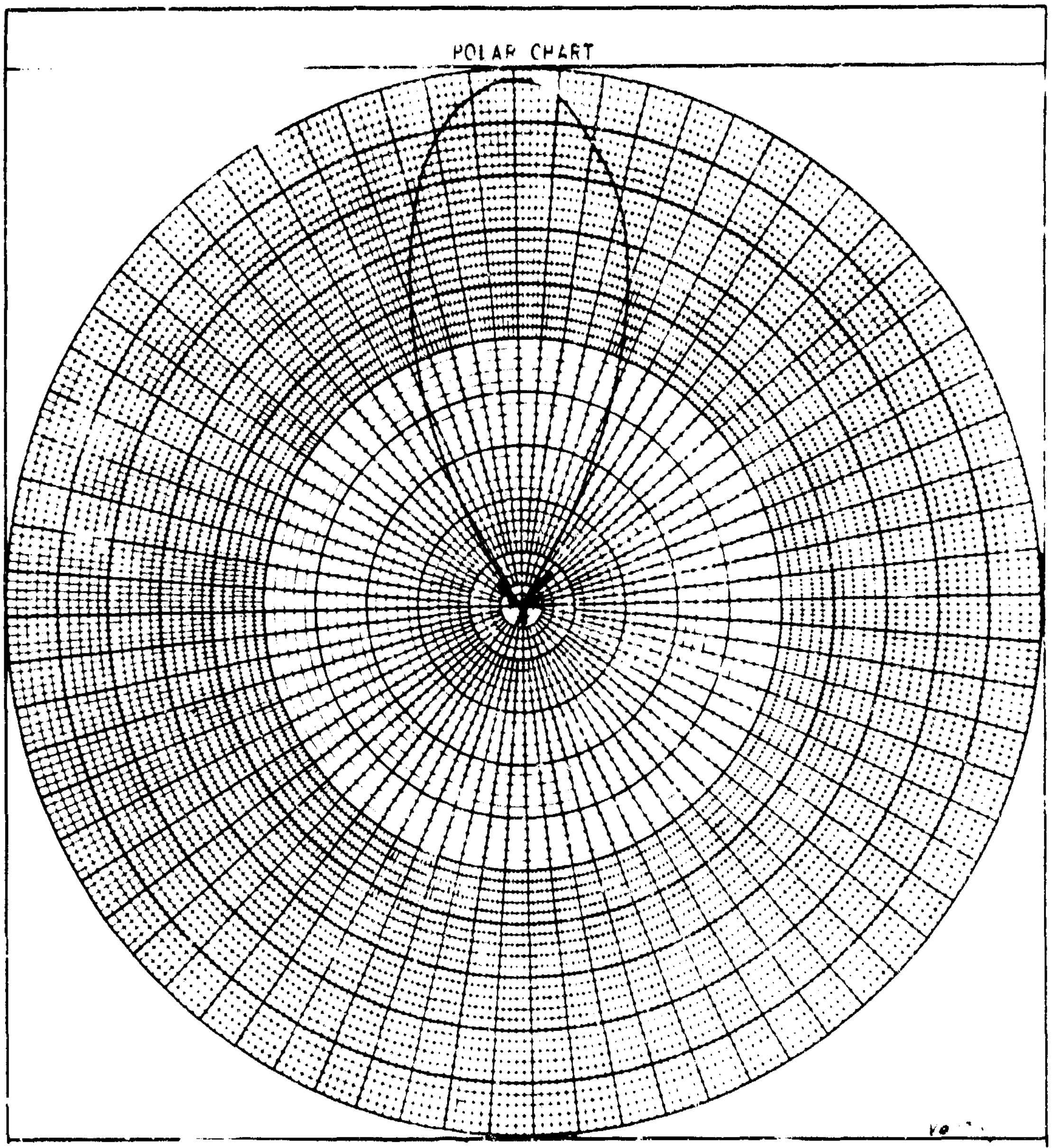
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 25 10 GHz H-PLANE



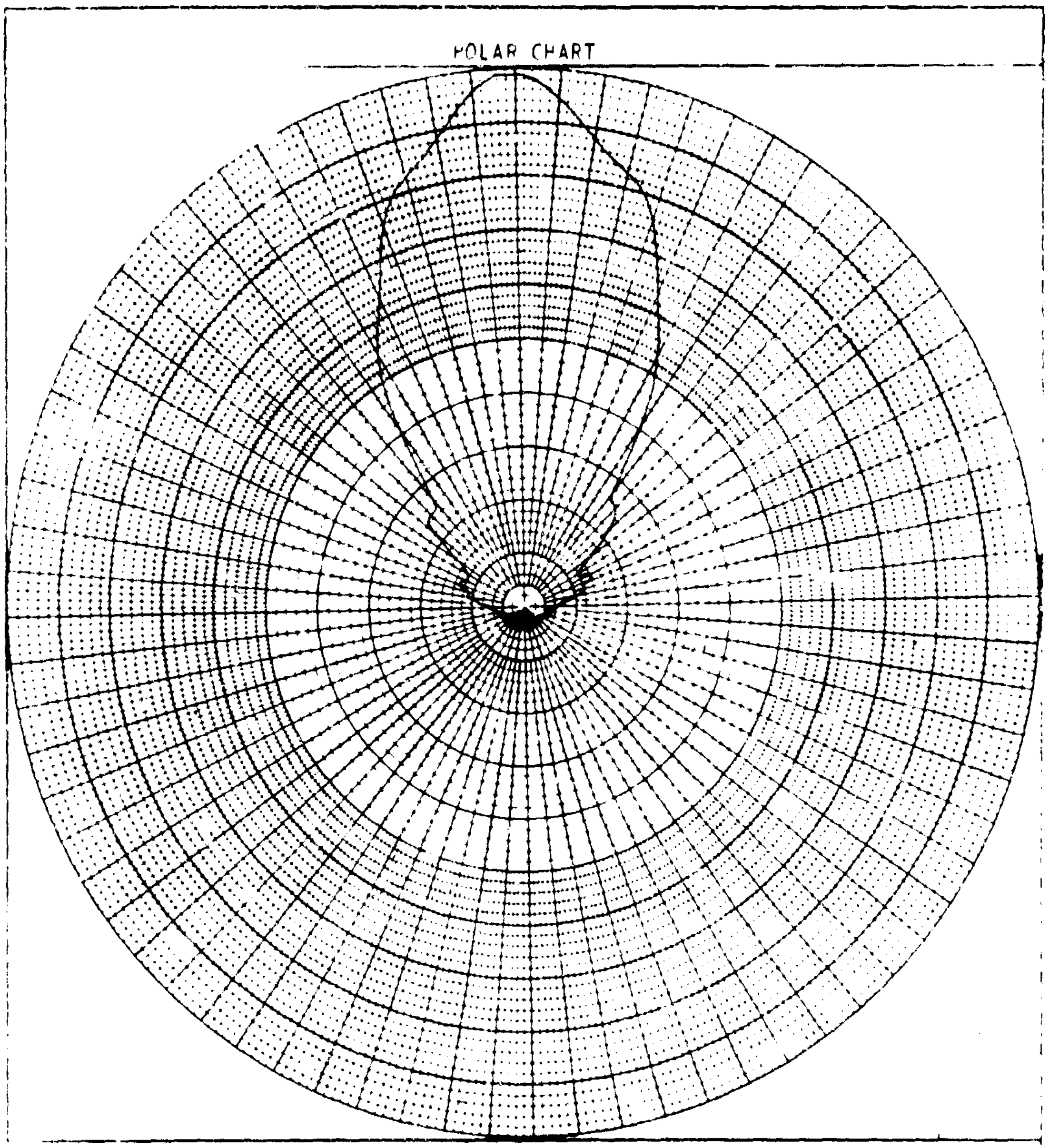
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 26 11.0 GHz E-PLANE



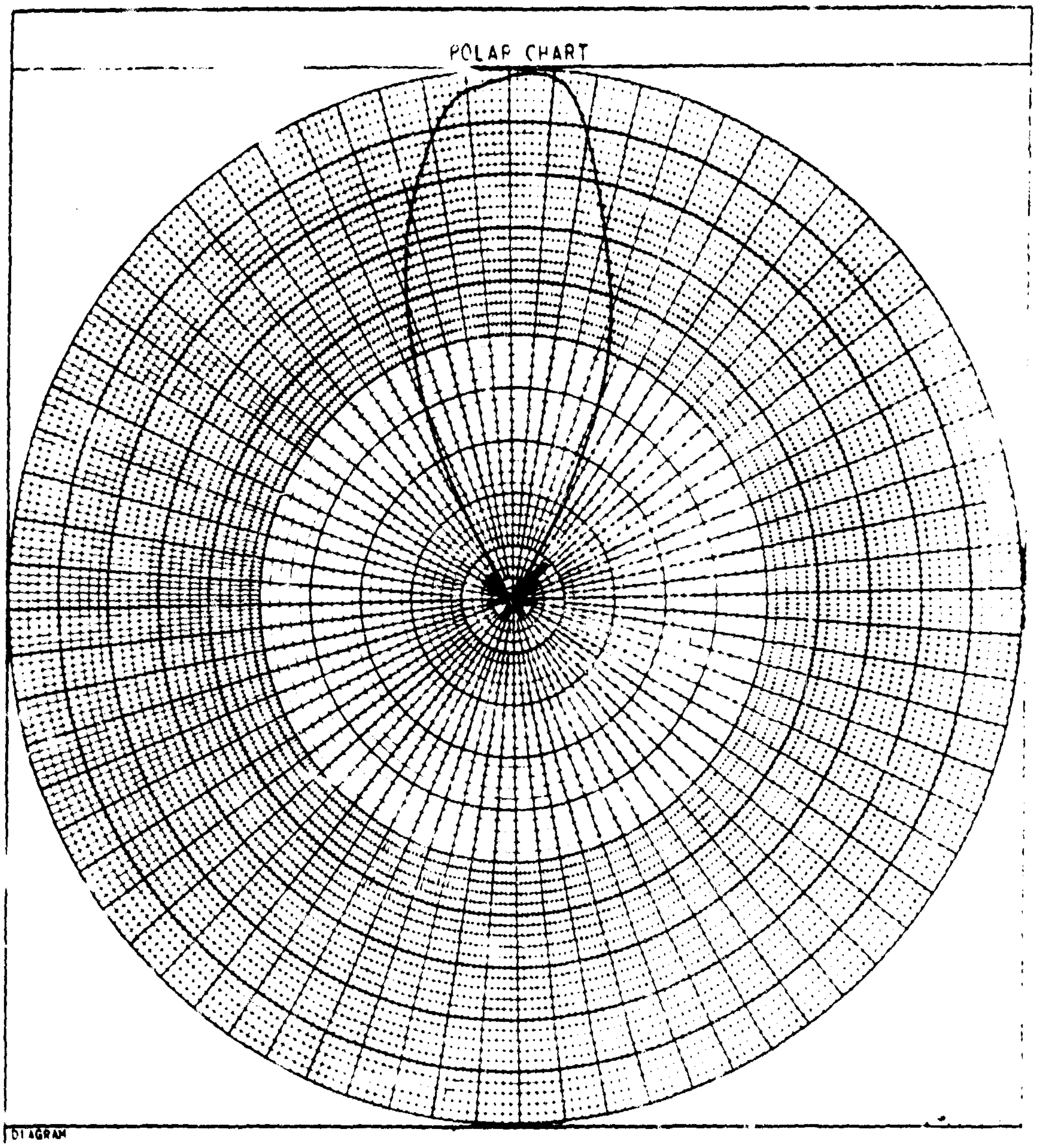
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 27 11.0 GHz H-PLANE



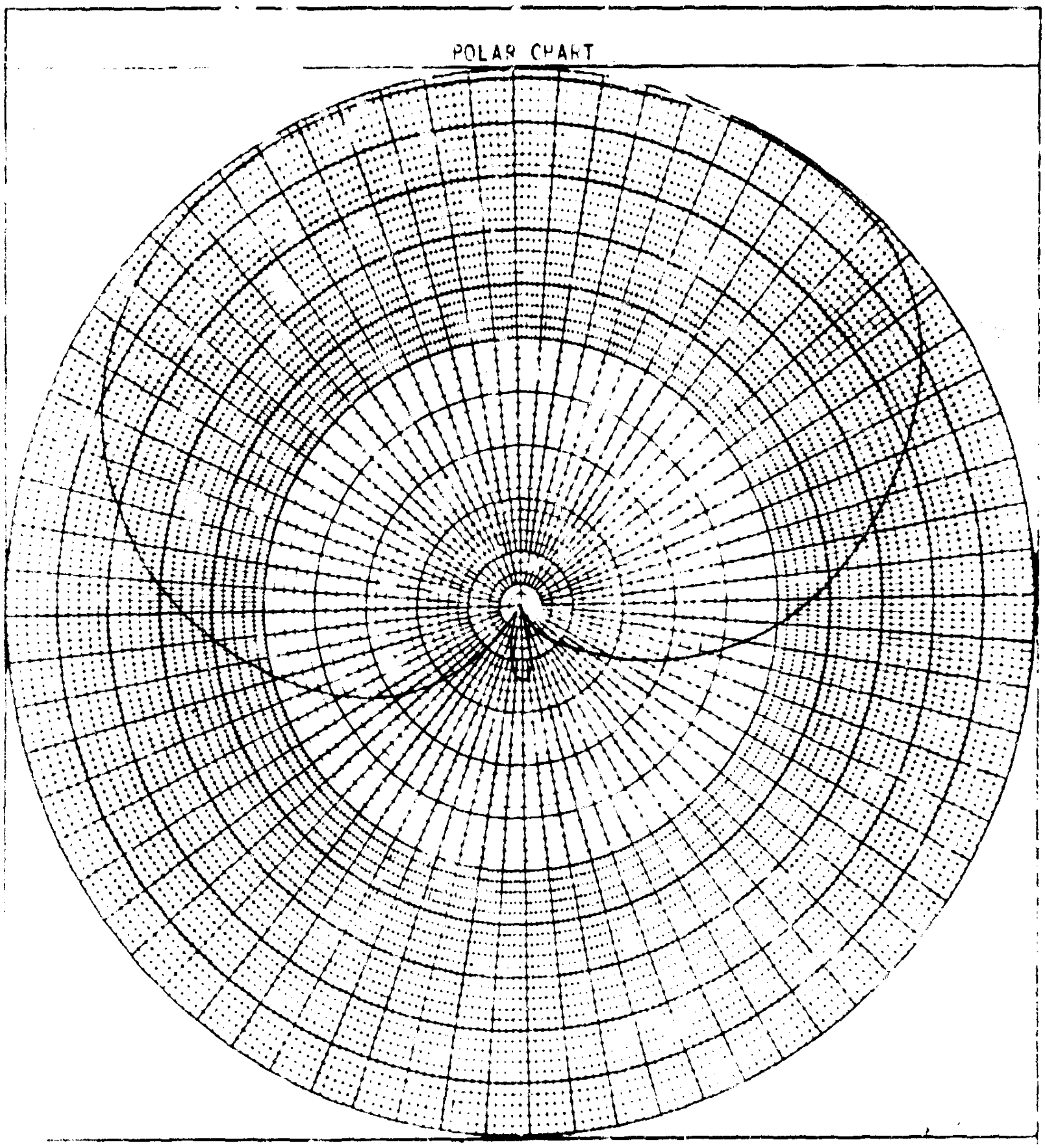
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 28 12.0 GHz E-PLANE



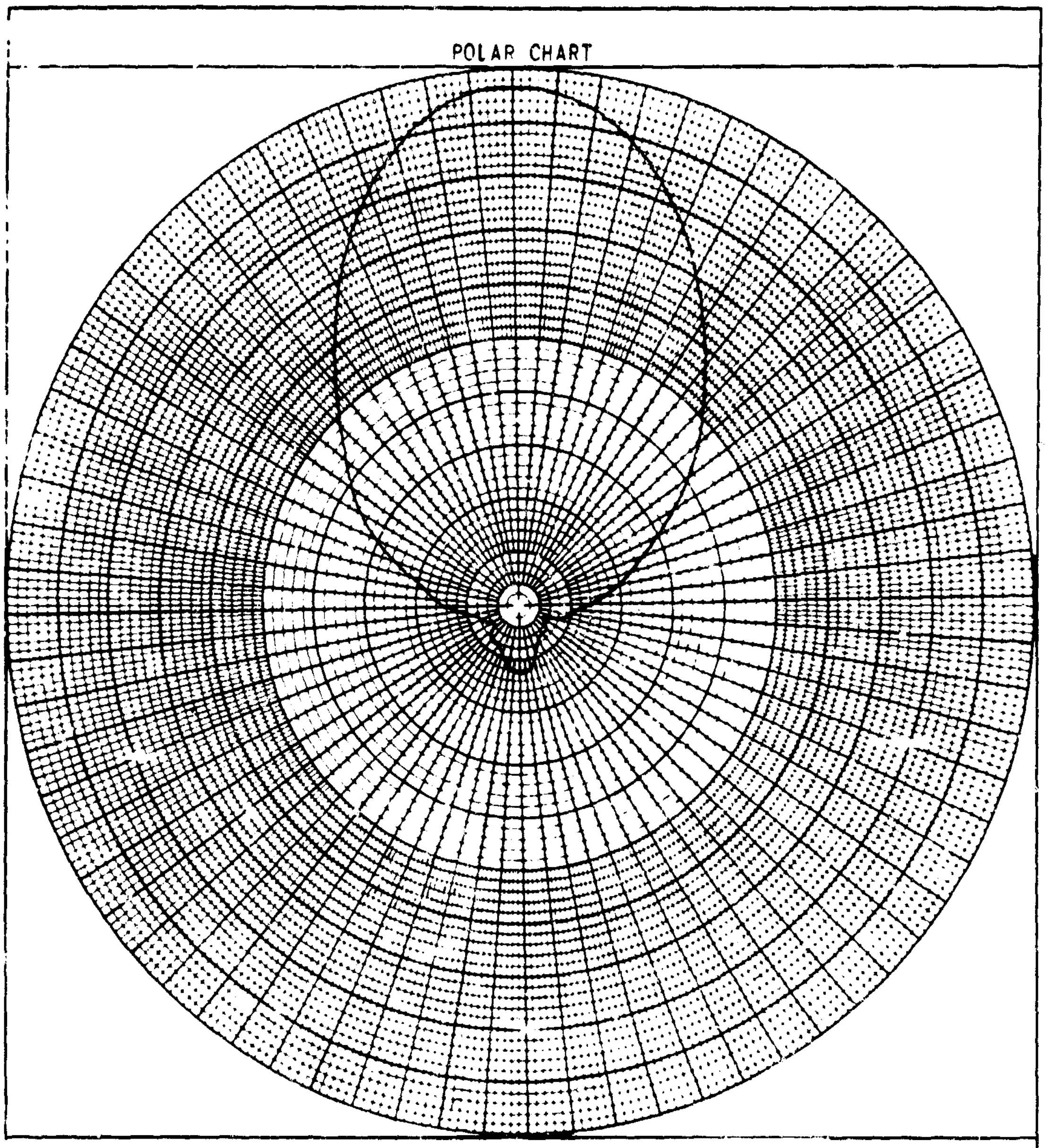
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 29 12.0 GHz H-PLANE



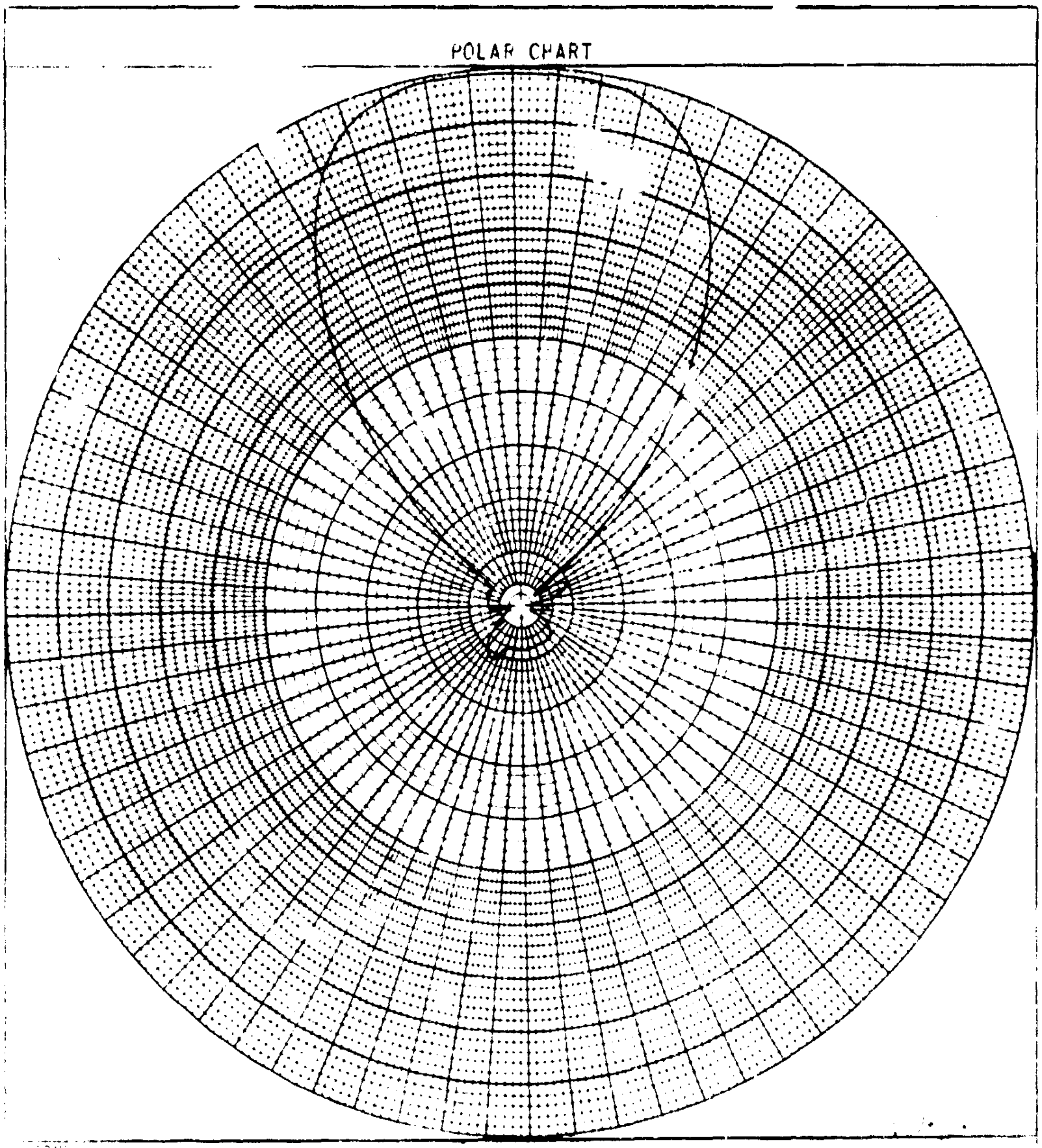
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)
(H-PLANE SIDES REMOVED)

FIGURE 30 1.4 GHz H-PLANE



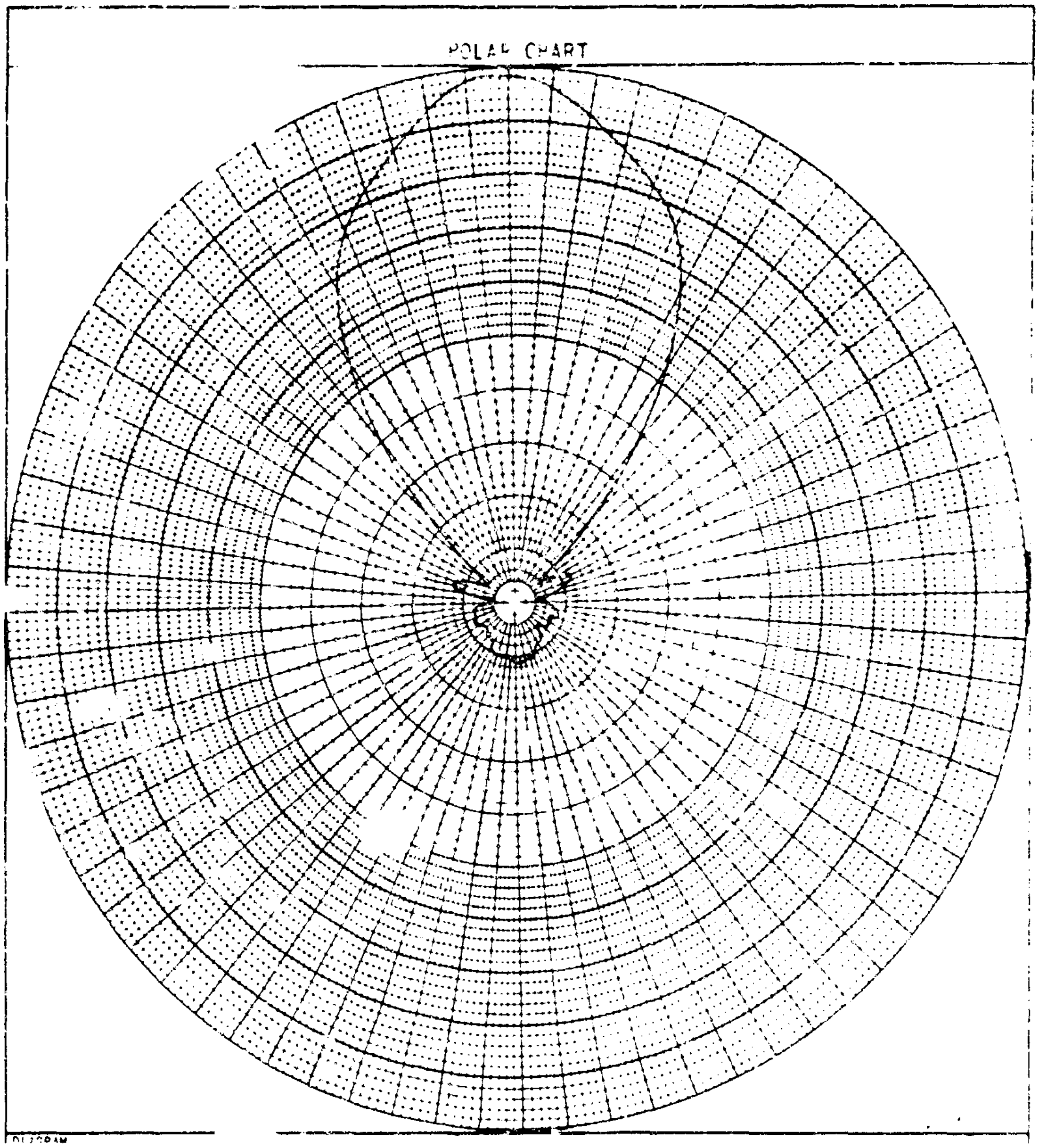
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)
(PRINTED CIRCUIT H-PLANE SIDES IN PLACE)

FIGURE 31 1.4 GHz H-PLANE



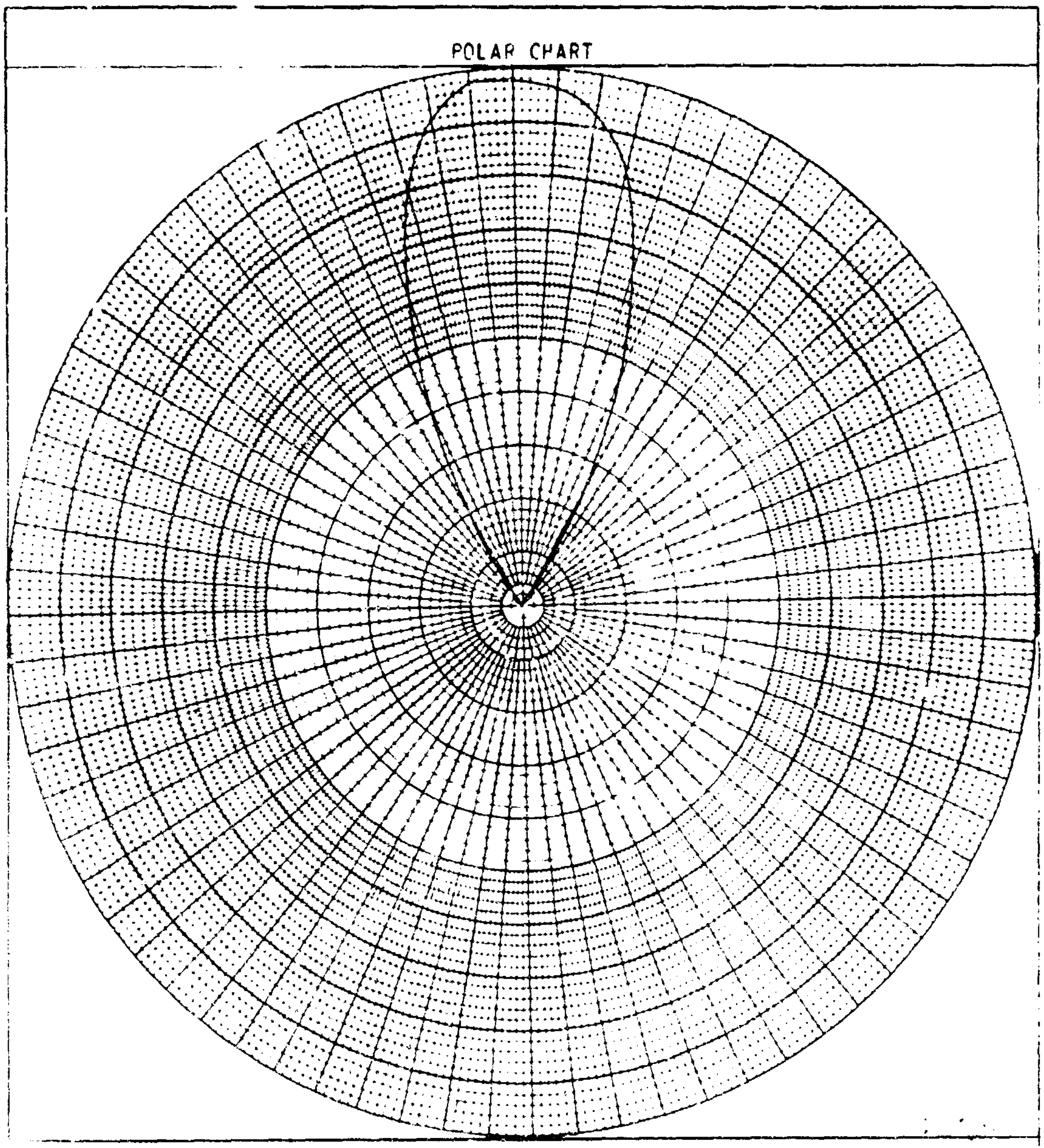
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)
(H-PLANE SIDES REMOVED)

FIGURE 32 3.5 GHz H-PLANE



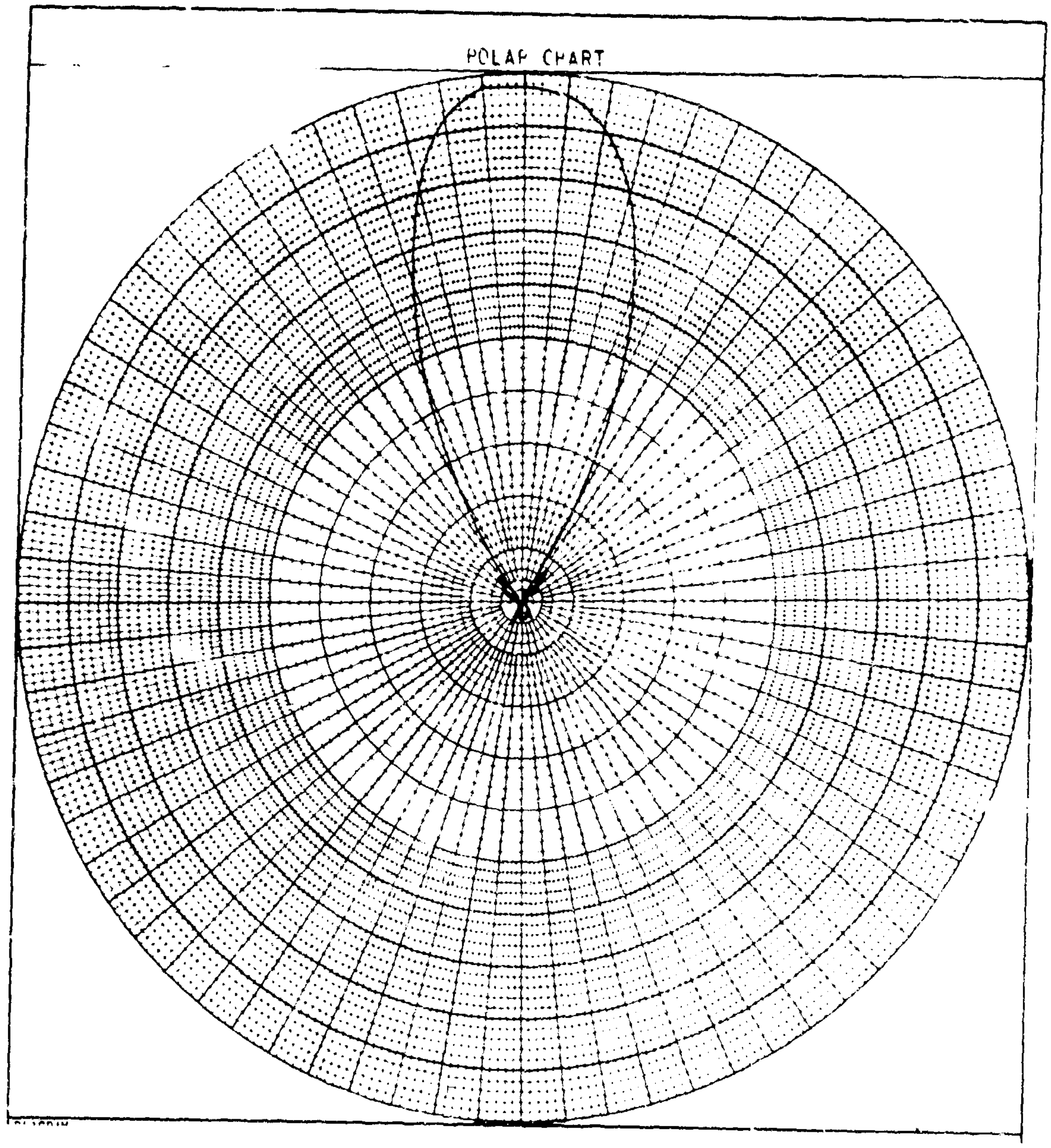
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)
(PRINTED CIRCUIT H-PLANE SIDES IN PLACE)

FIGURE 33 3.5 GHz H-PLANE



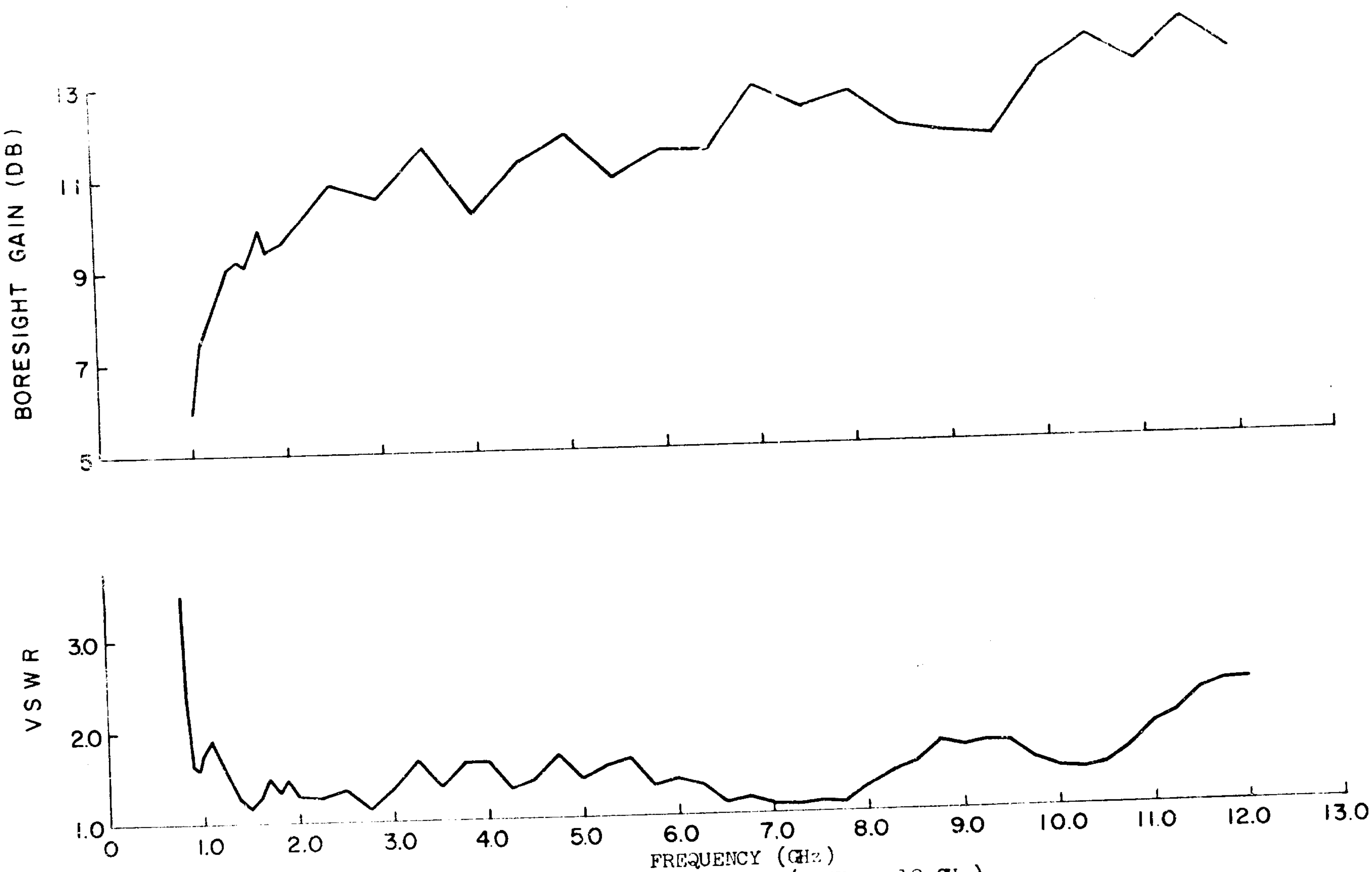
SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)
(H-PLANE SIDES REMOVED)

FIGURE 34 10.5 GHz H-PLANE



SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)
(PRINTED CIRCUIT SIDES IN PLACE)

FIGURE 35 10.5 GHz H-PLANE



SHORT AXIAL LENGTH HORN (1 GHz - 12 GHz)

FIGURE 30 - VSWR AND GAIN

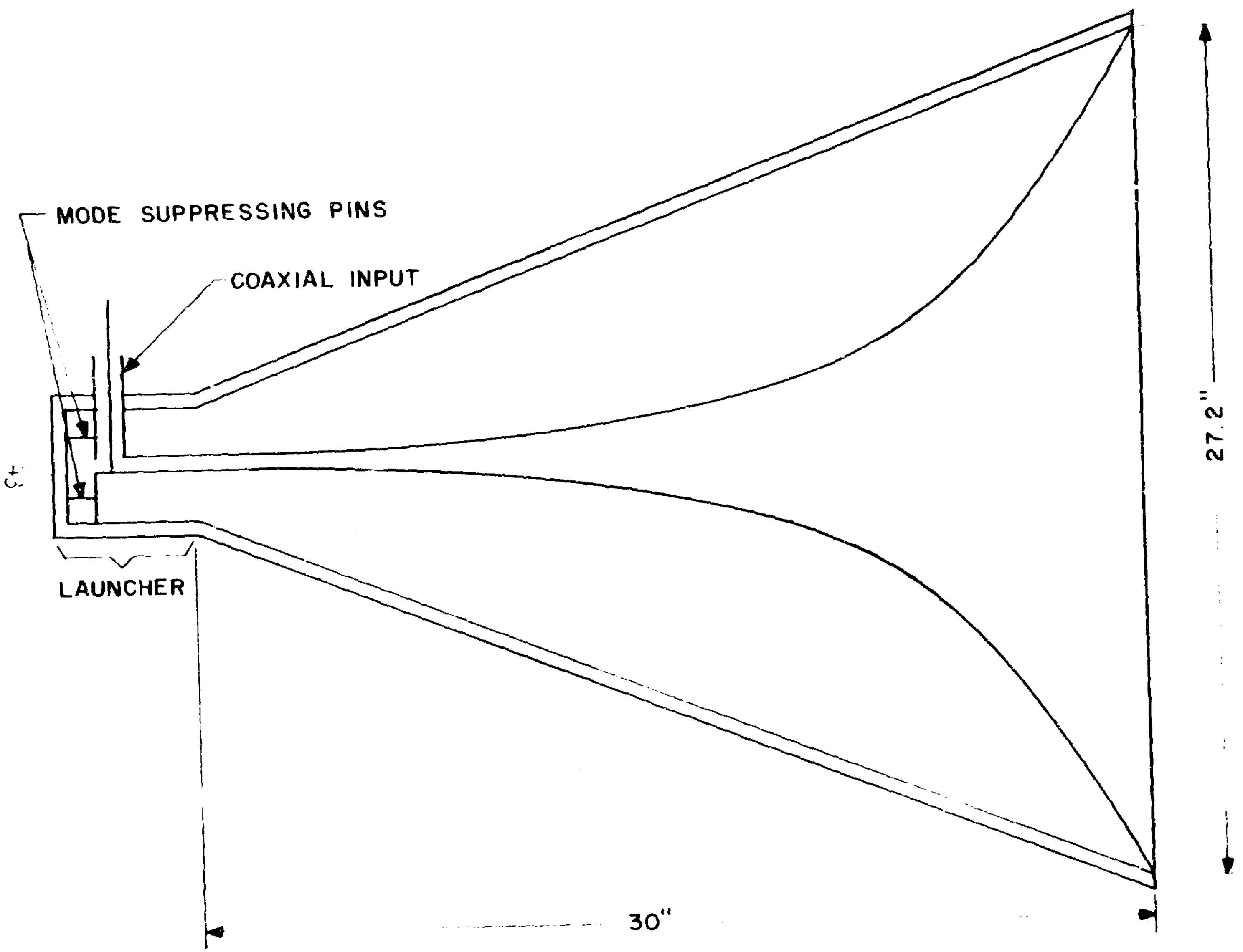
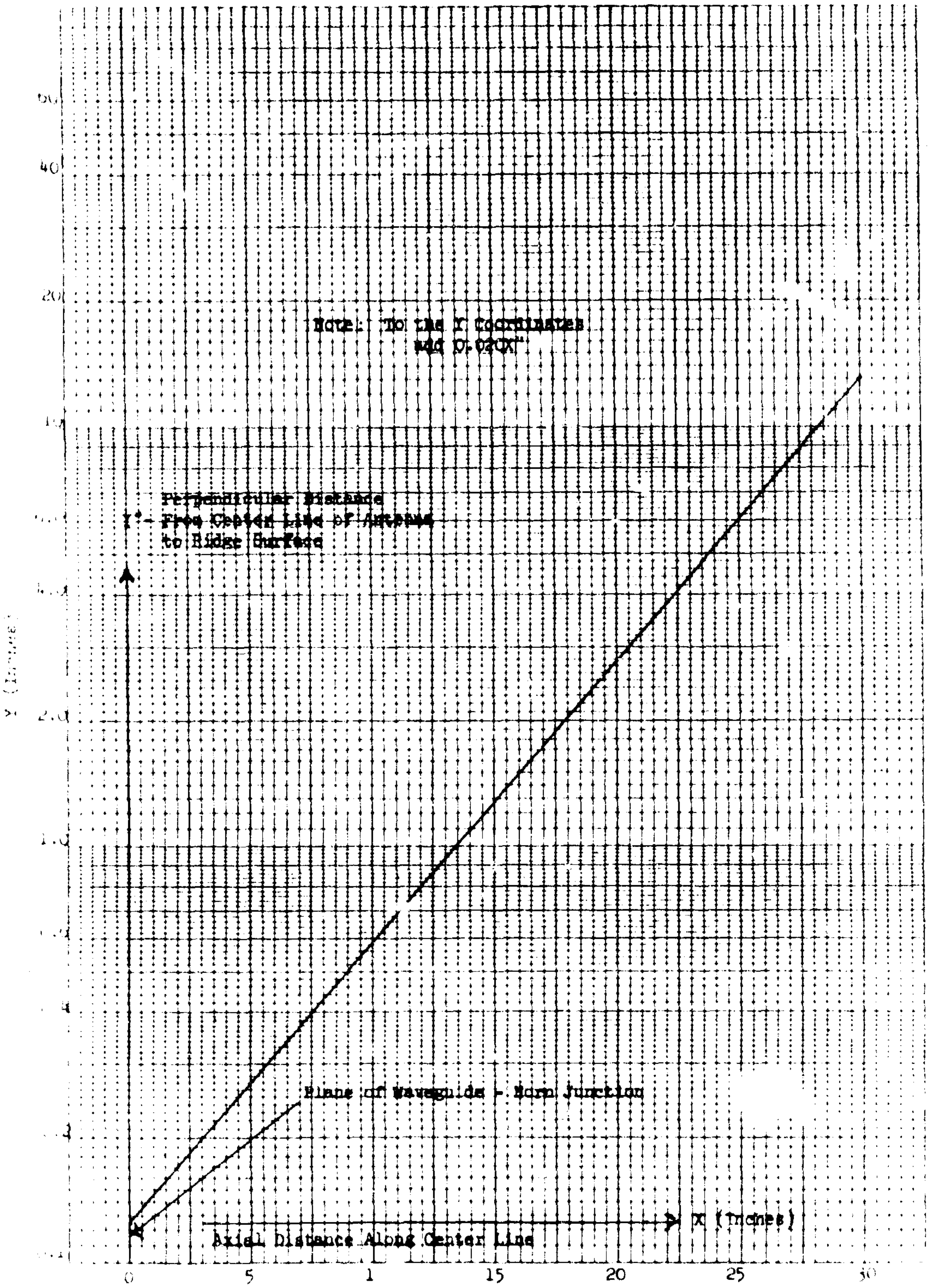


FIGURE 37 - SHORT AXIAL LENGTH HORN (0.2 GHz - 2.0 GHz)

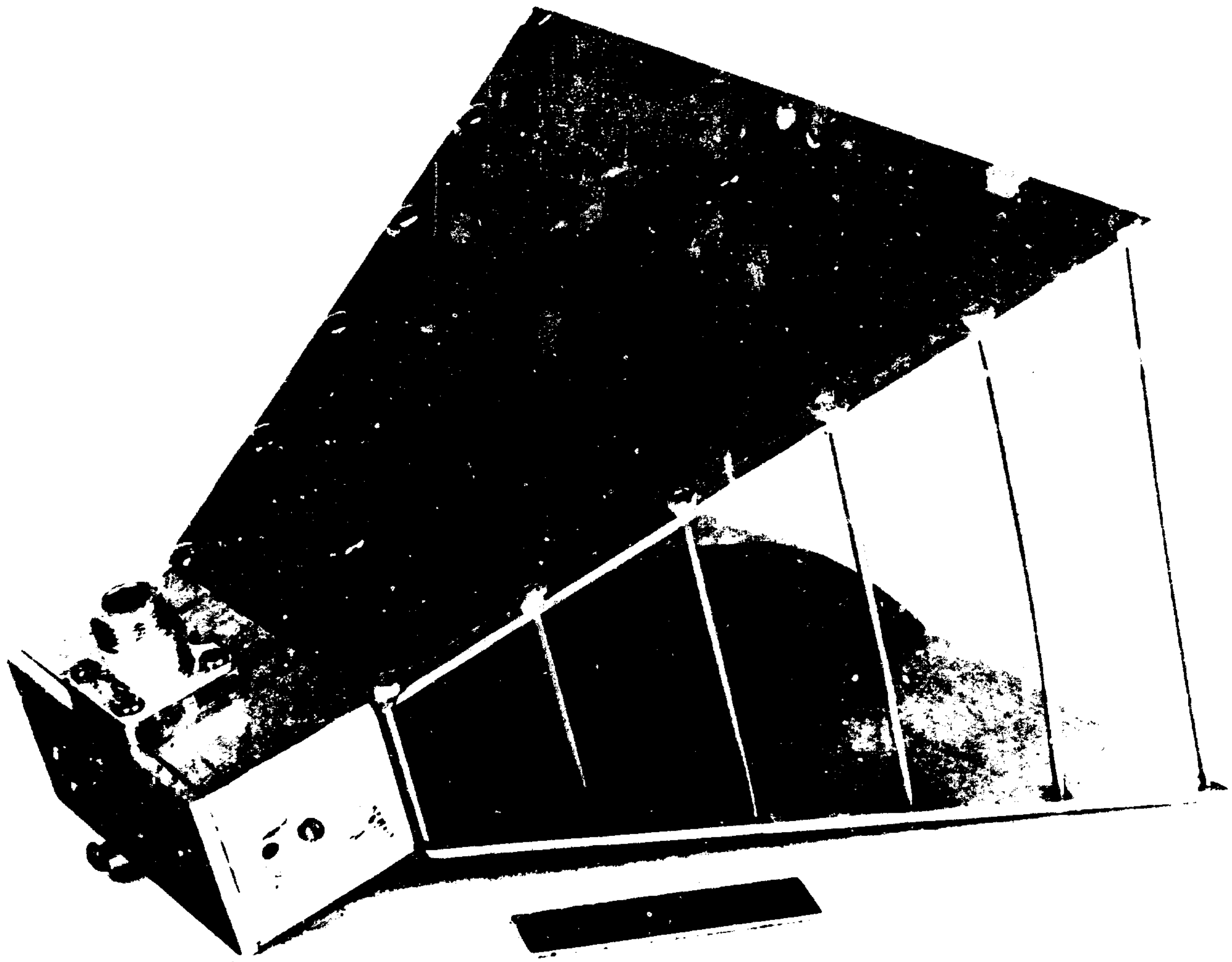


SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 38 - RIDGE CURVE COORDINATES

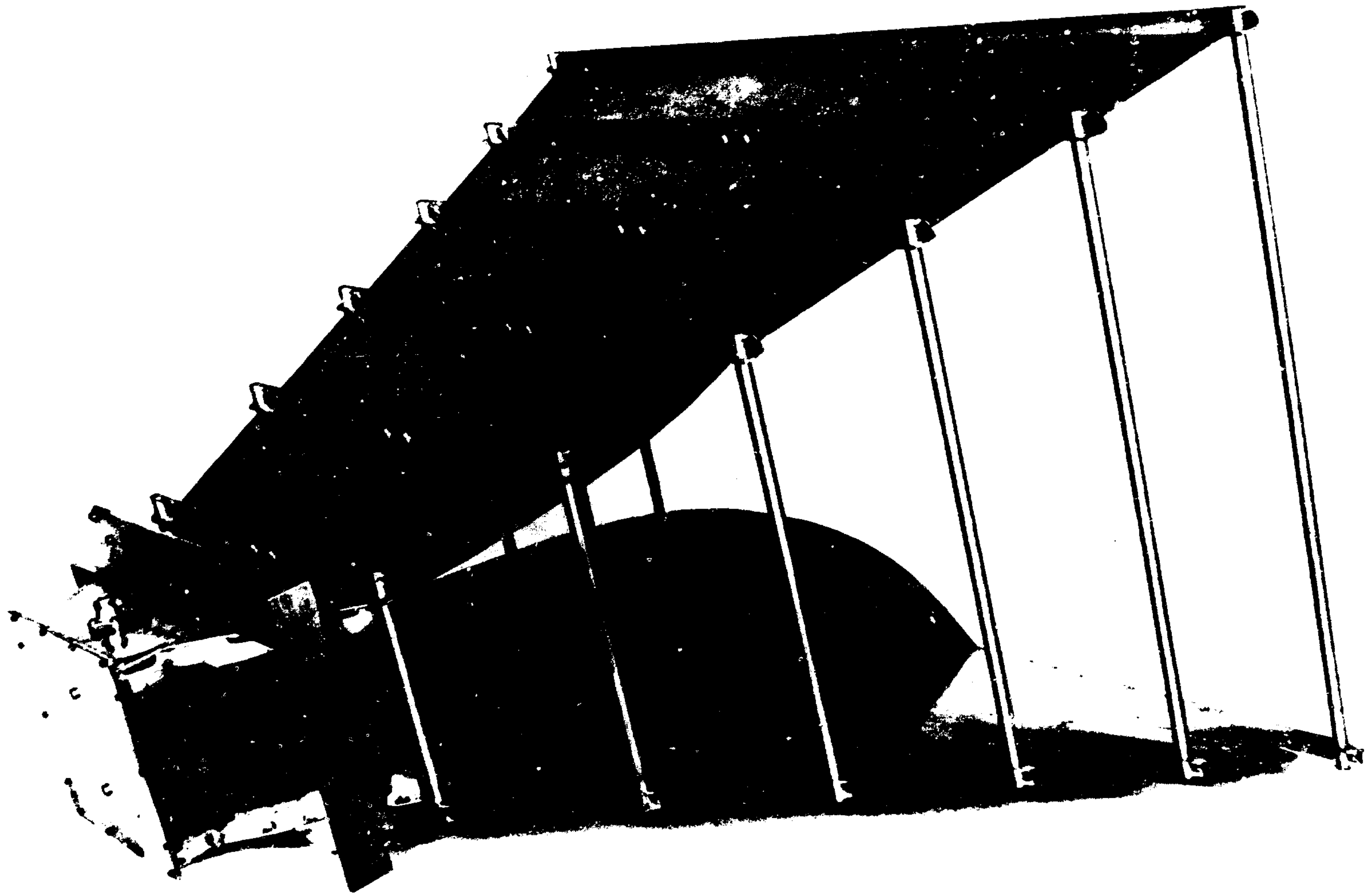
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 39 - FIRST DEVELOPMENT MODEL



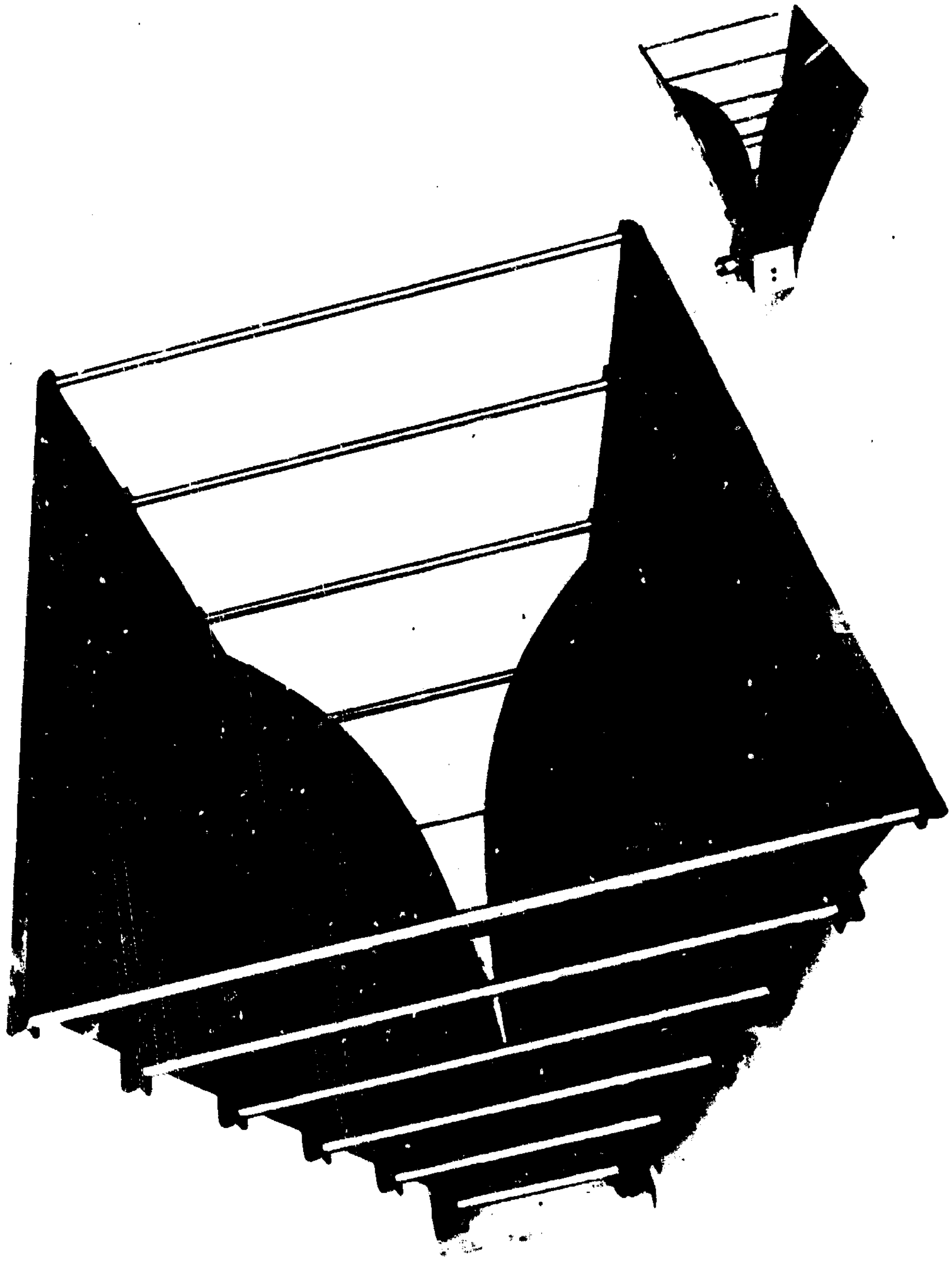
SHORT AXIAL LENGTH HORN

FIGURE 40 - 1/5 SCALE MODEL



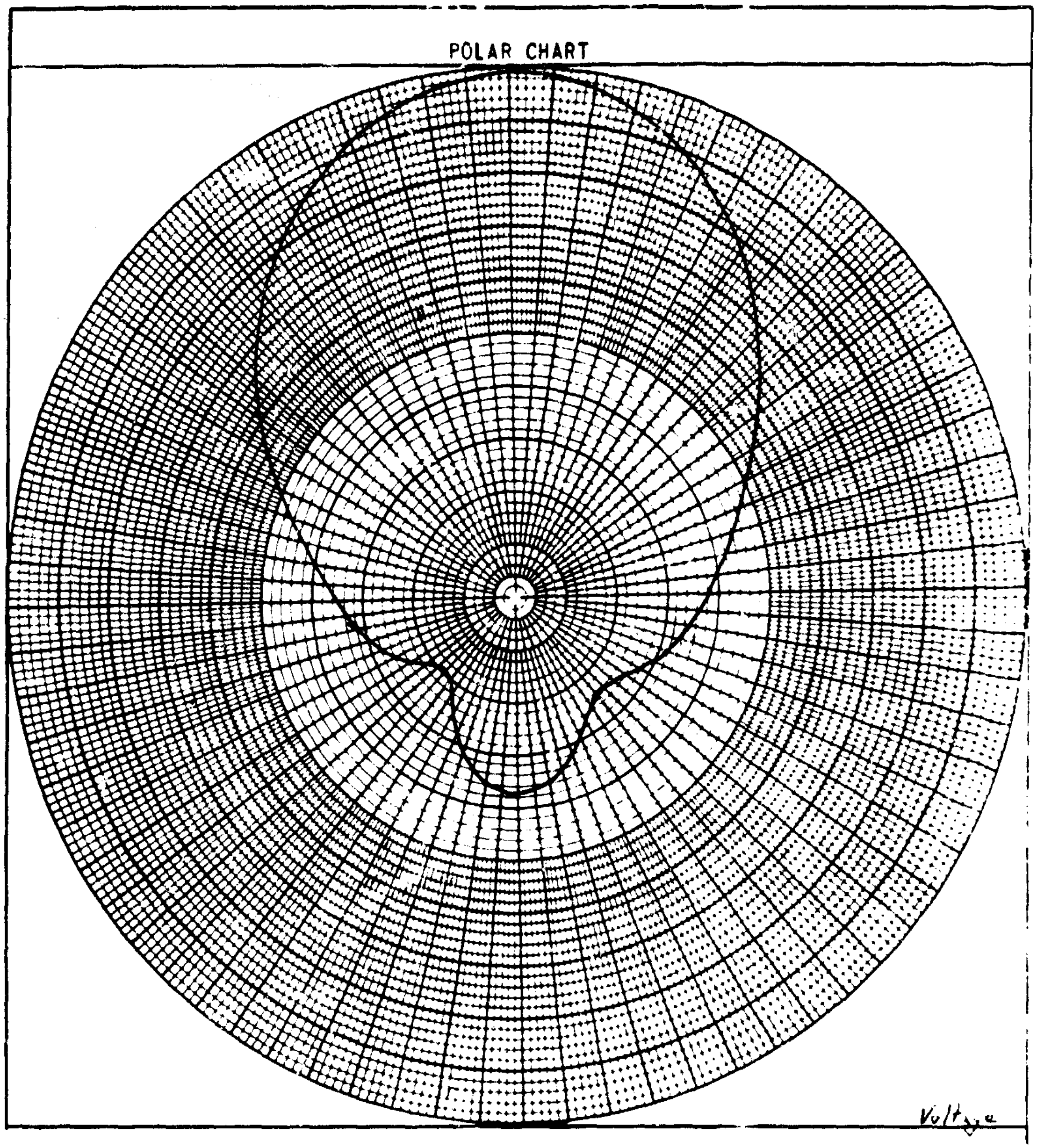
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 41 - FINAL DEVELOPMENT MODEL



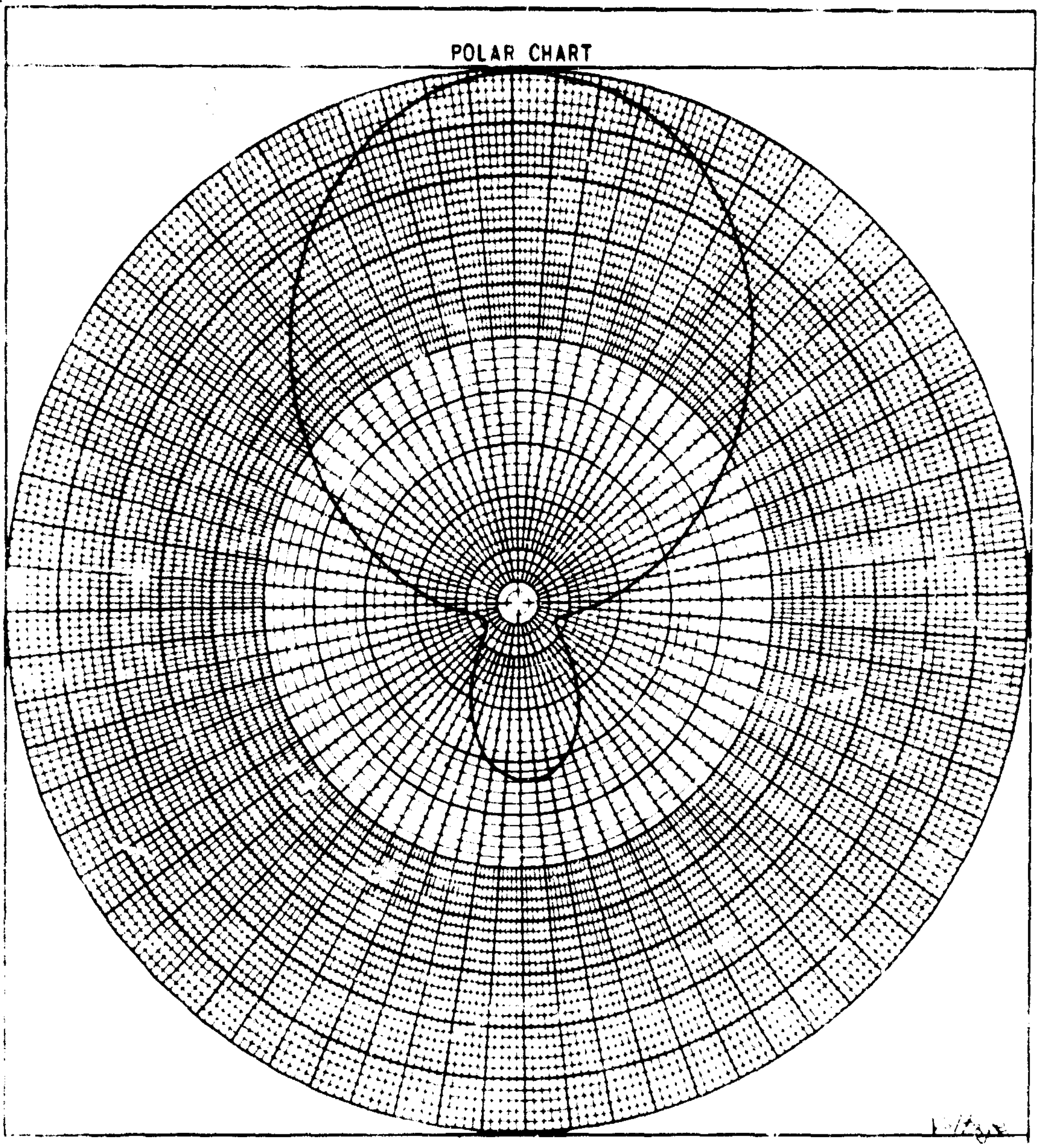
SHORT AXIAL LENGTH HORN (0.2 GHz - 2.0 GHz) AND 1/5-SCALE MODEL

FIGURE 42 - COMPARISON VIEW



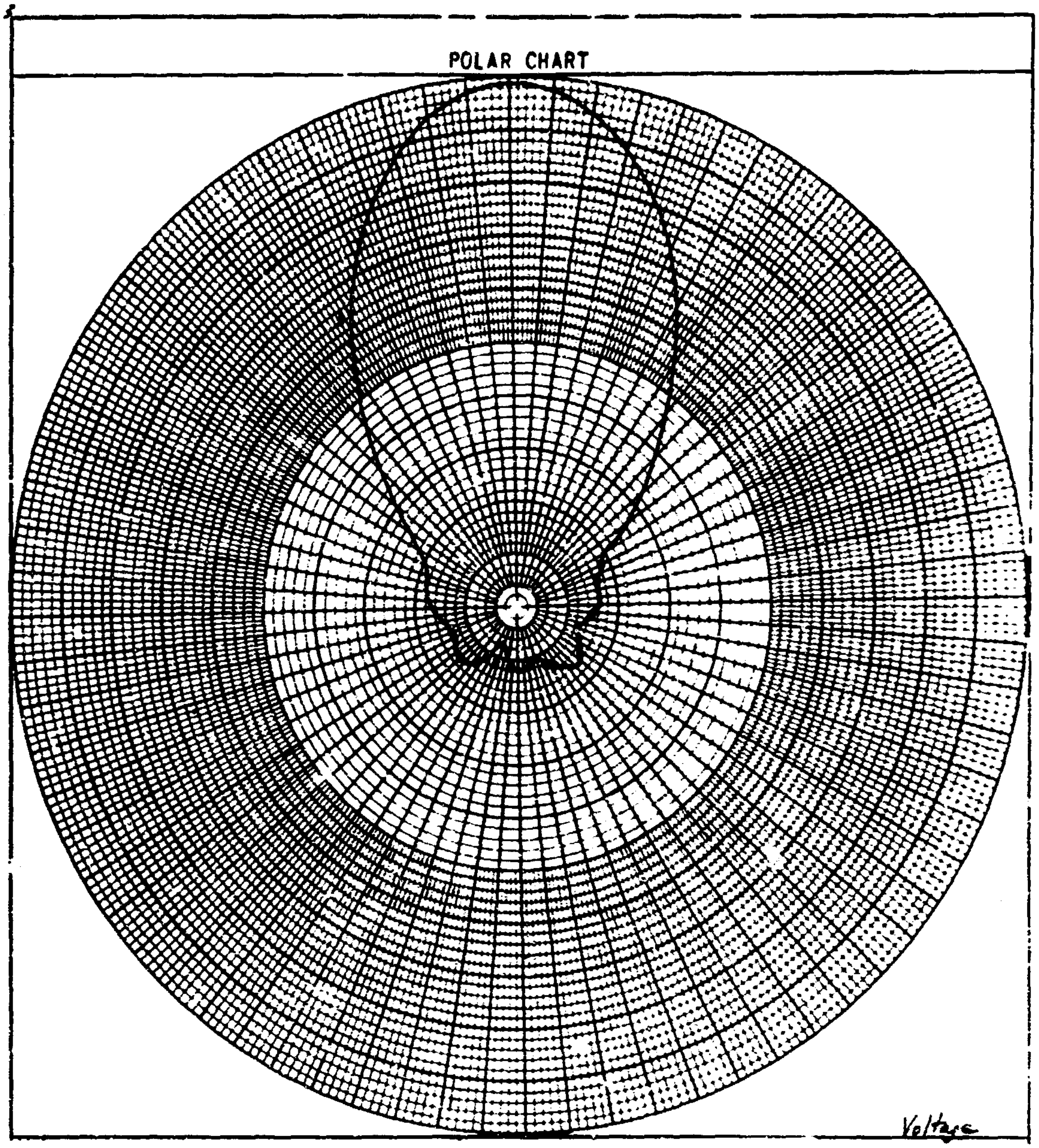
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 43 0.2 GHz E-PLANE



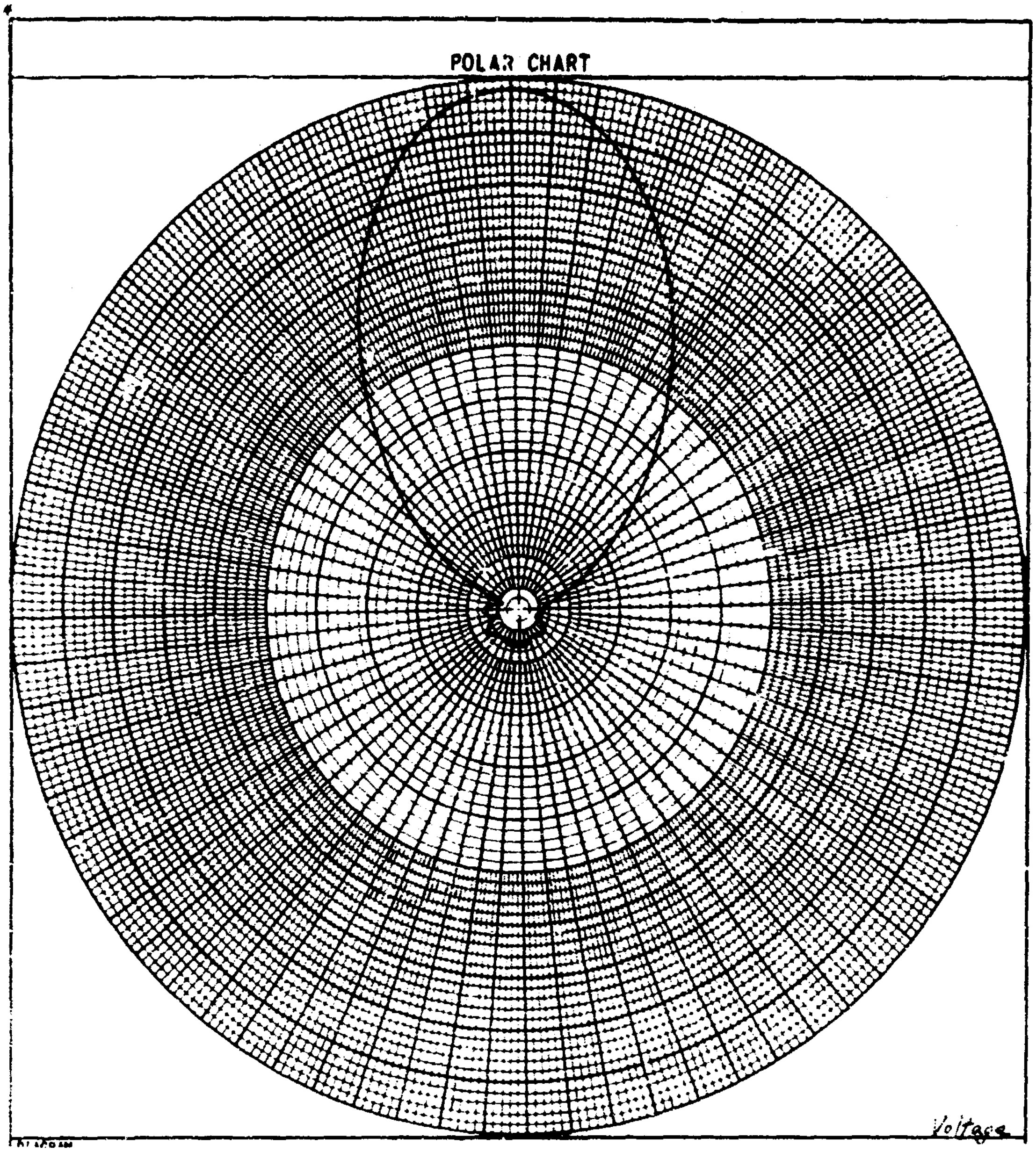
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 44 0.2 GHz H-PLANE



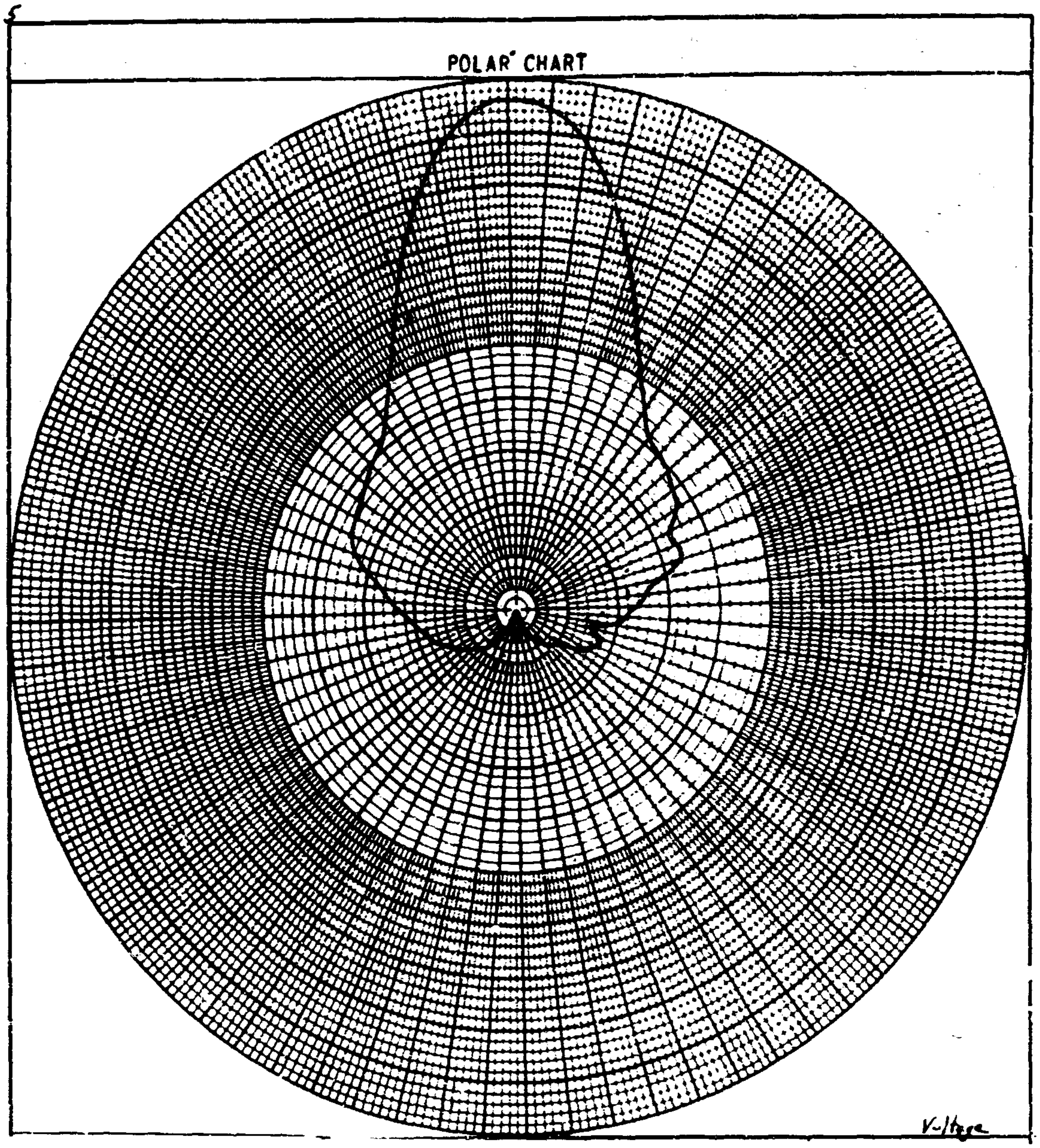
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 45 0.4 Ghz E-PLANE



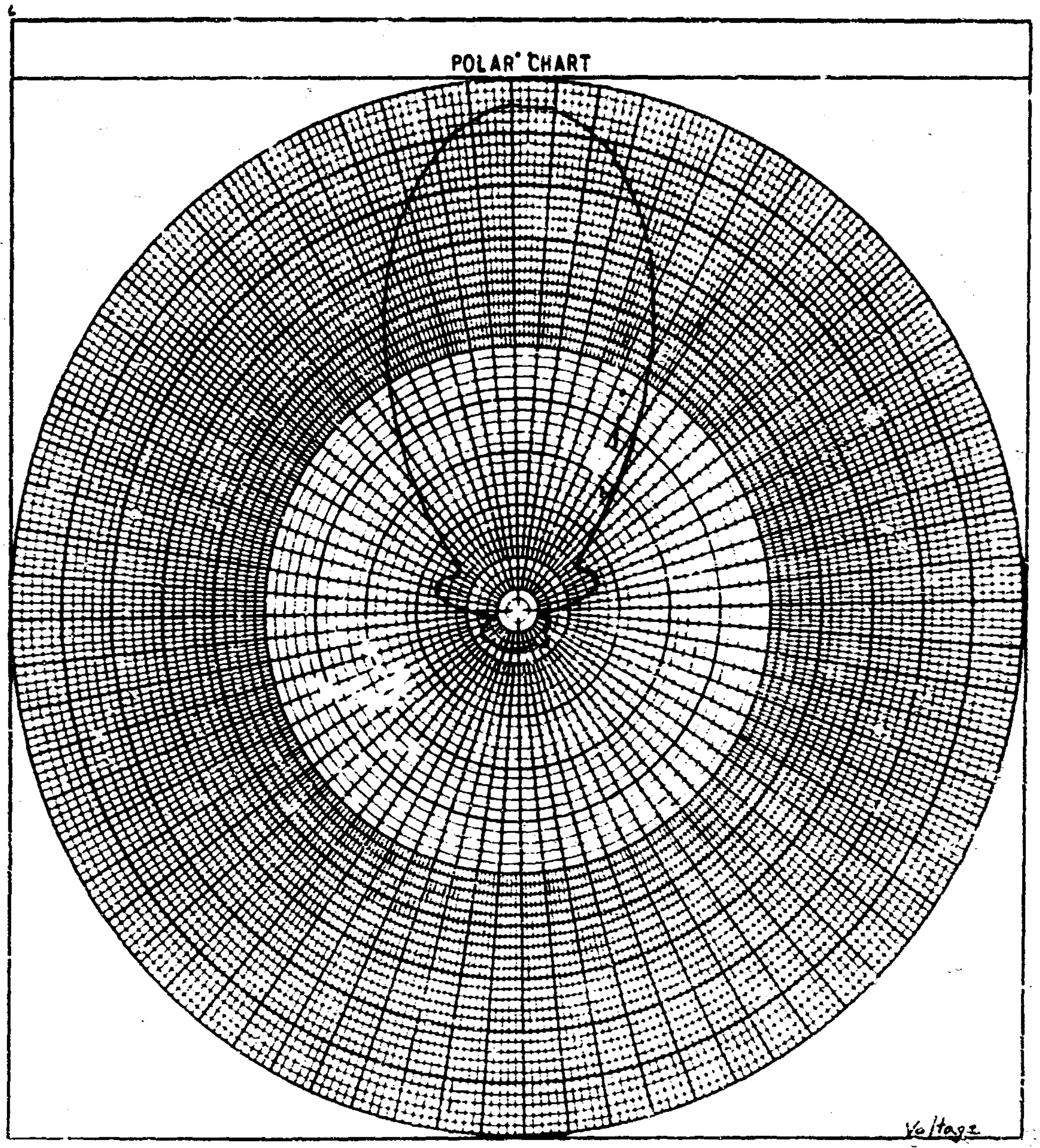
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 46 0.4 GHz H-PLANE



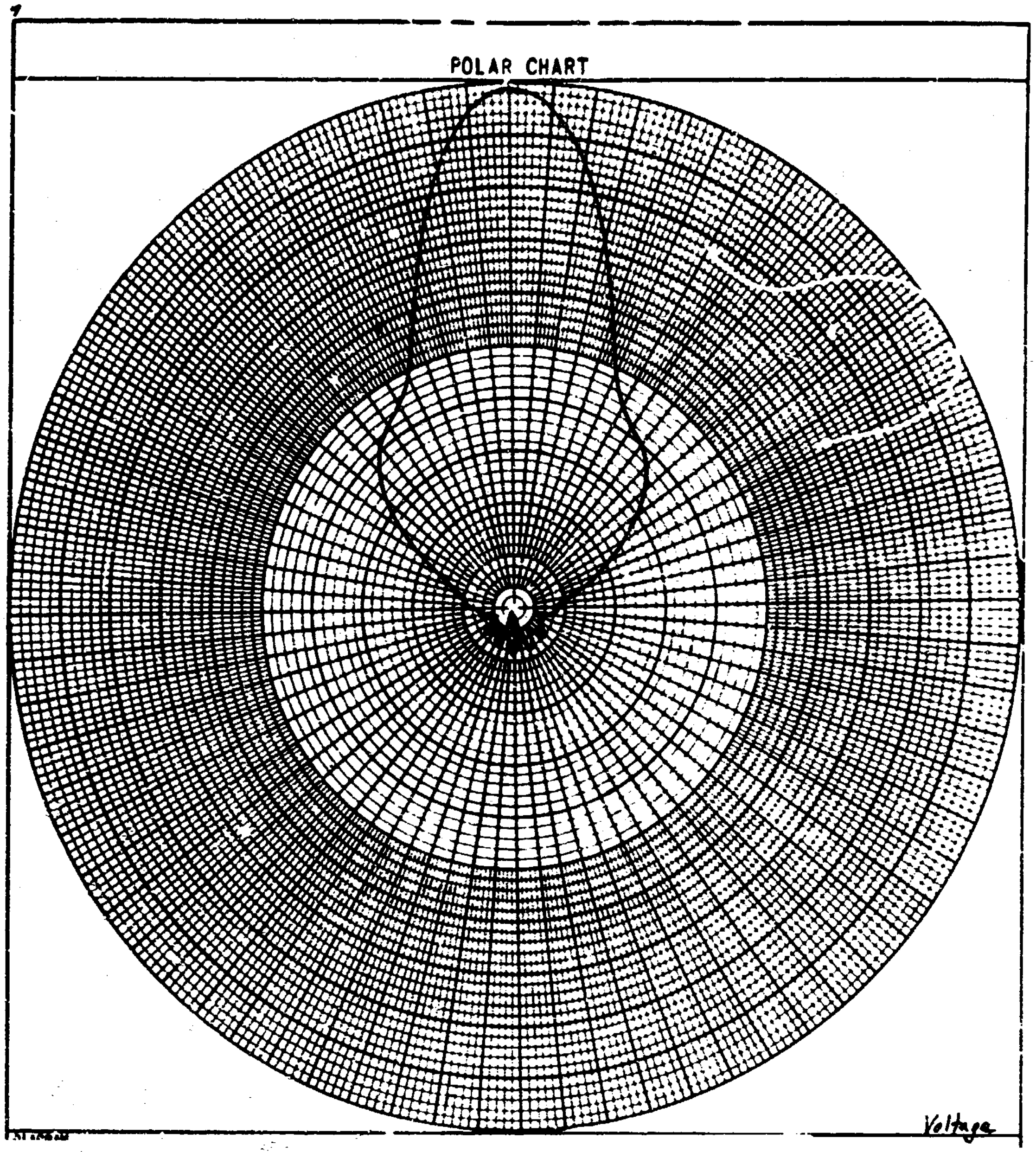
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 47 0.6 GHz E-PLANE



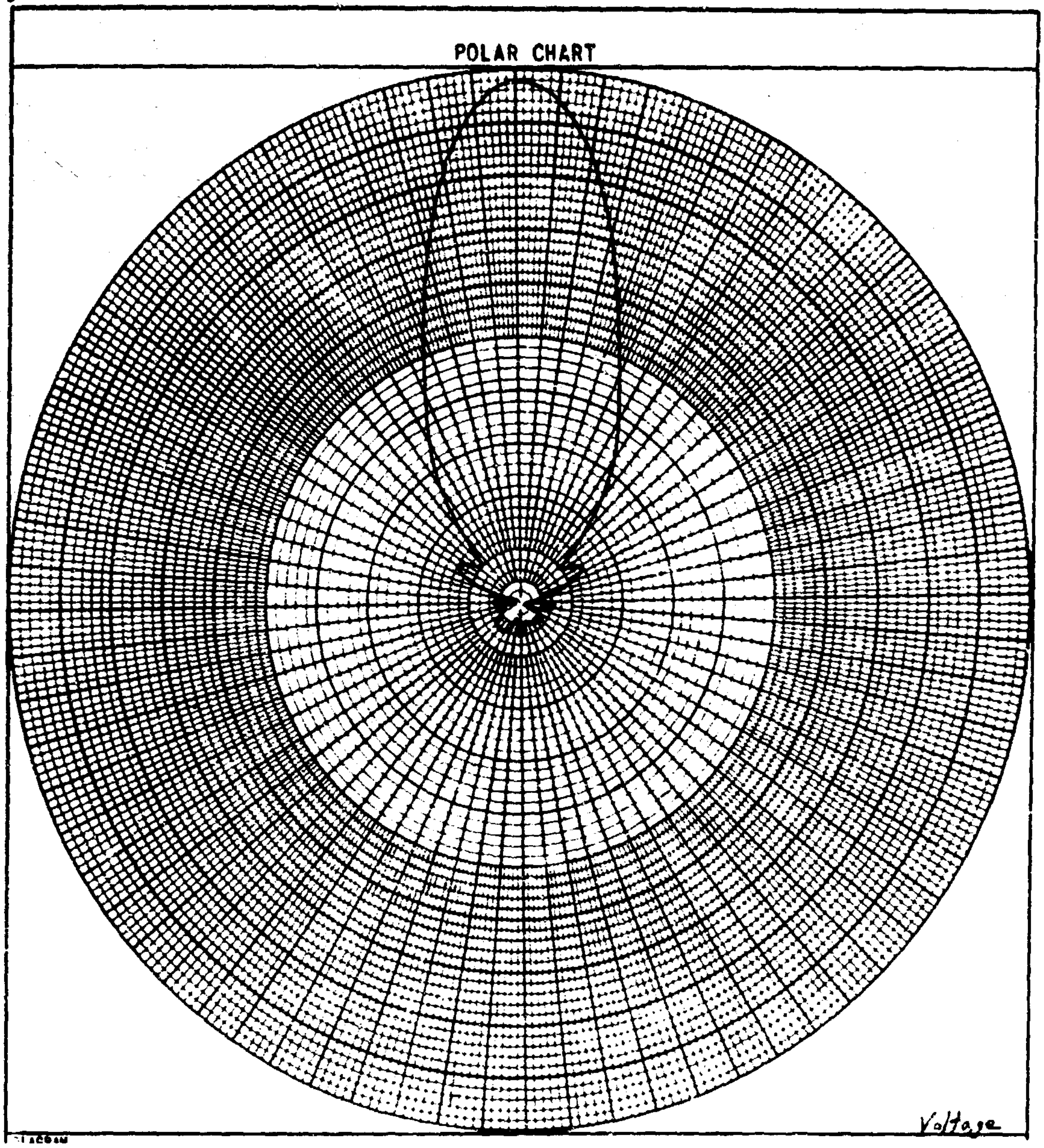
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 48 0.6 GHz H-PLANE



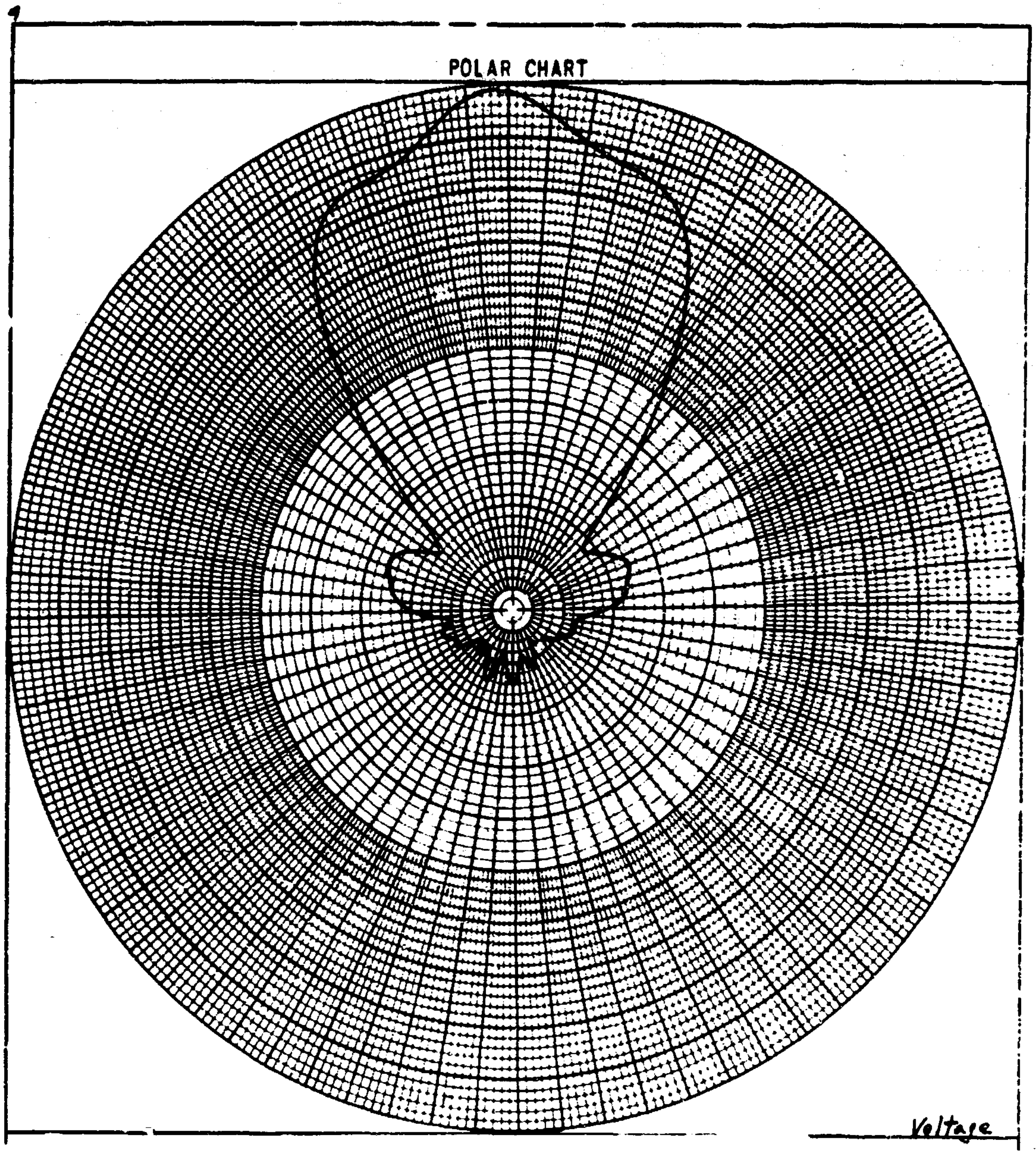
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 49 0.8 GHz E-PLANE



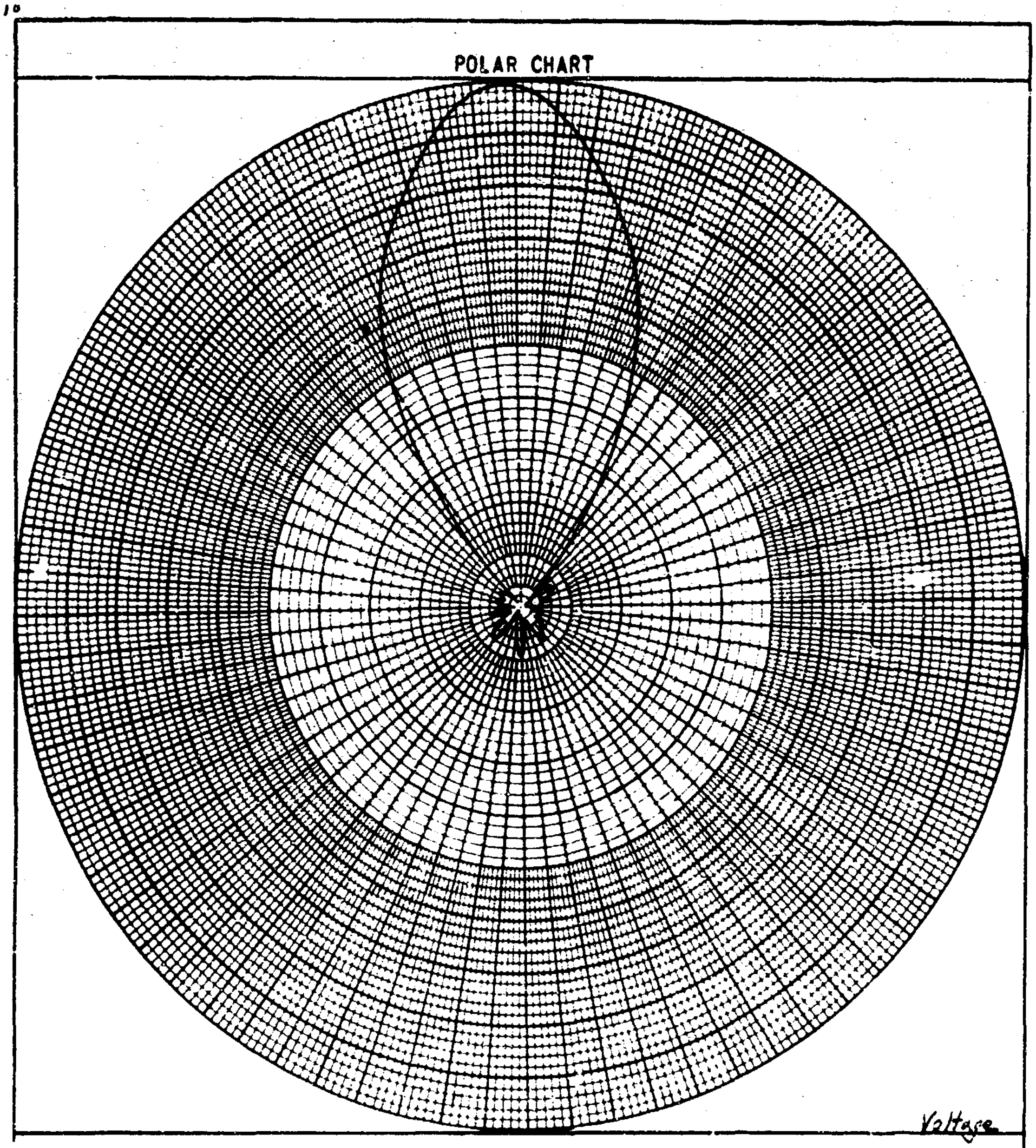
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 50 0.8 GHz H-PLANE



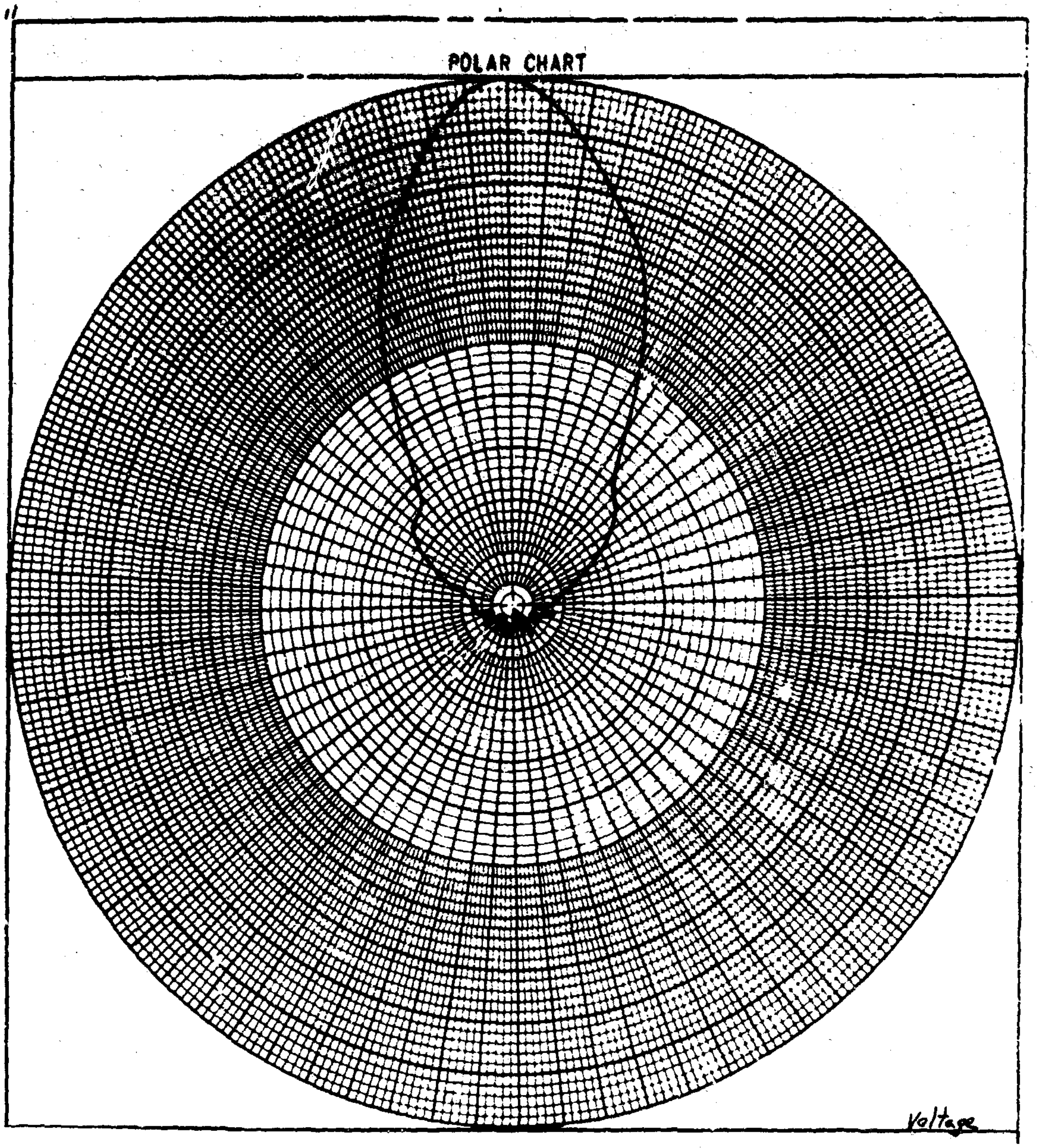
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 51 1.0 GHz E-PLANE



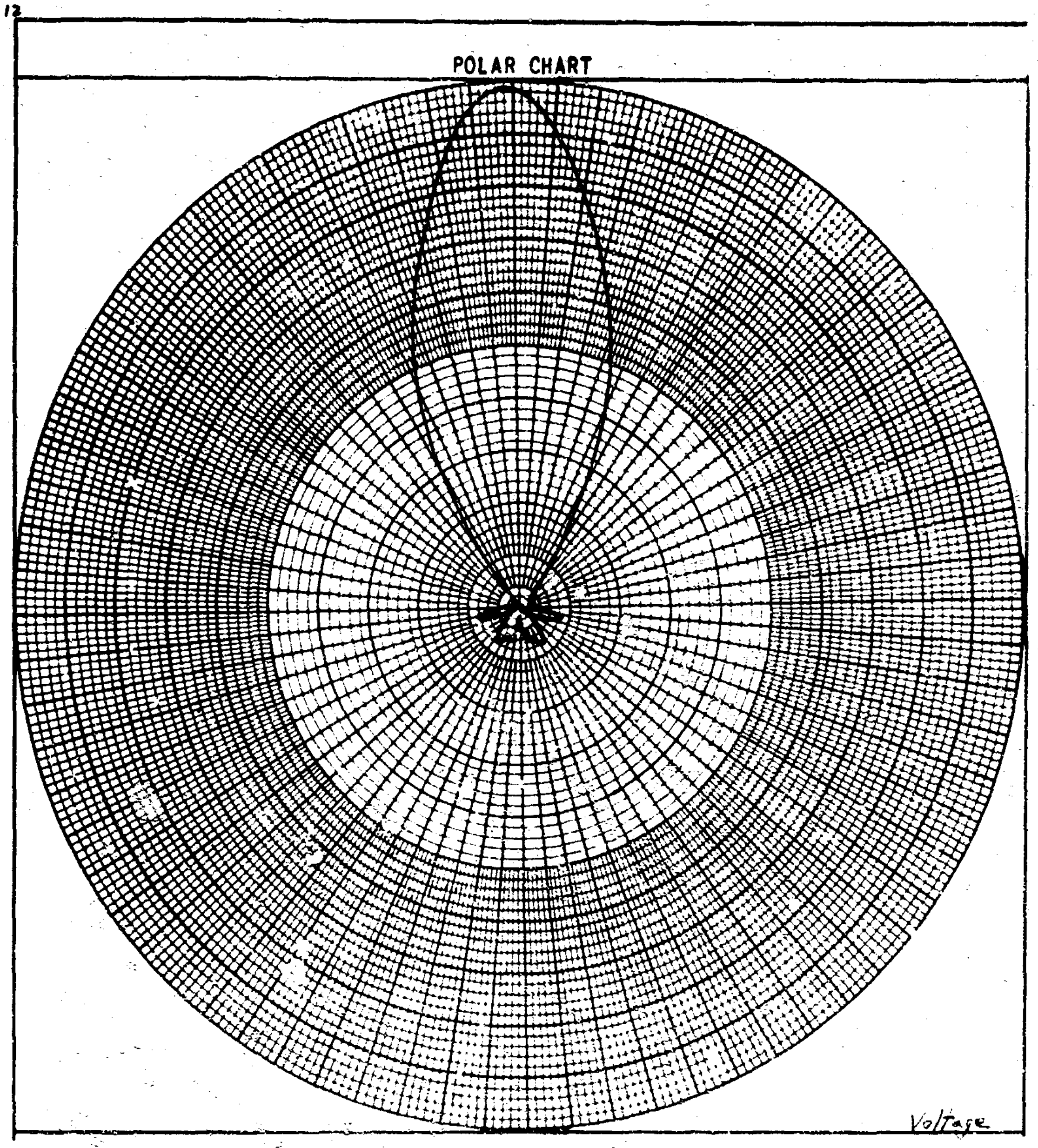
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 52 1.0 GHz H-PLANE



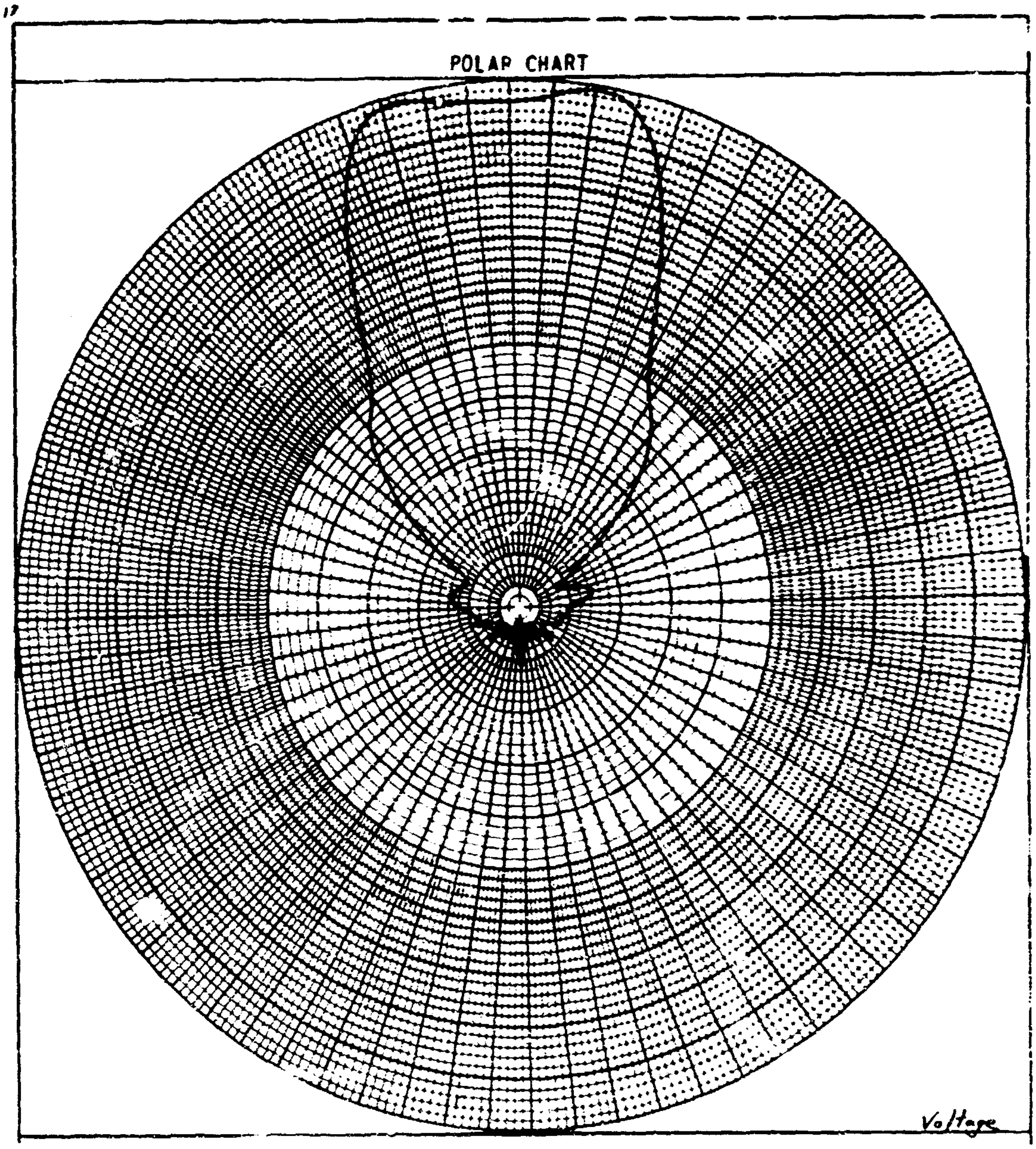
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 53 1.2 GHz E-PLANE



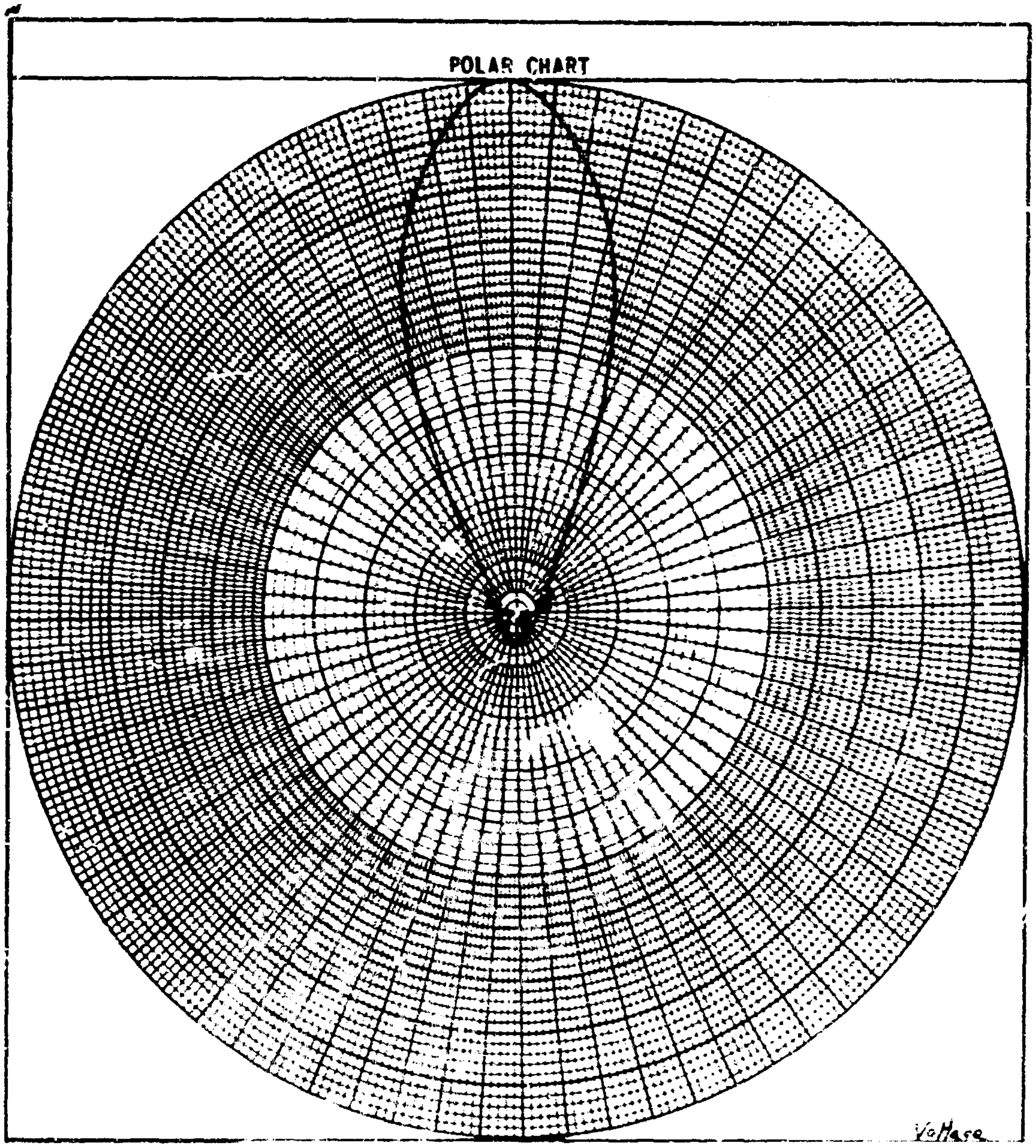
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 54 1.2 GHz H-PLANE



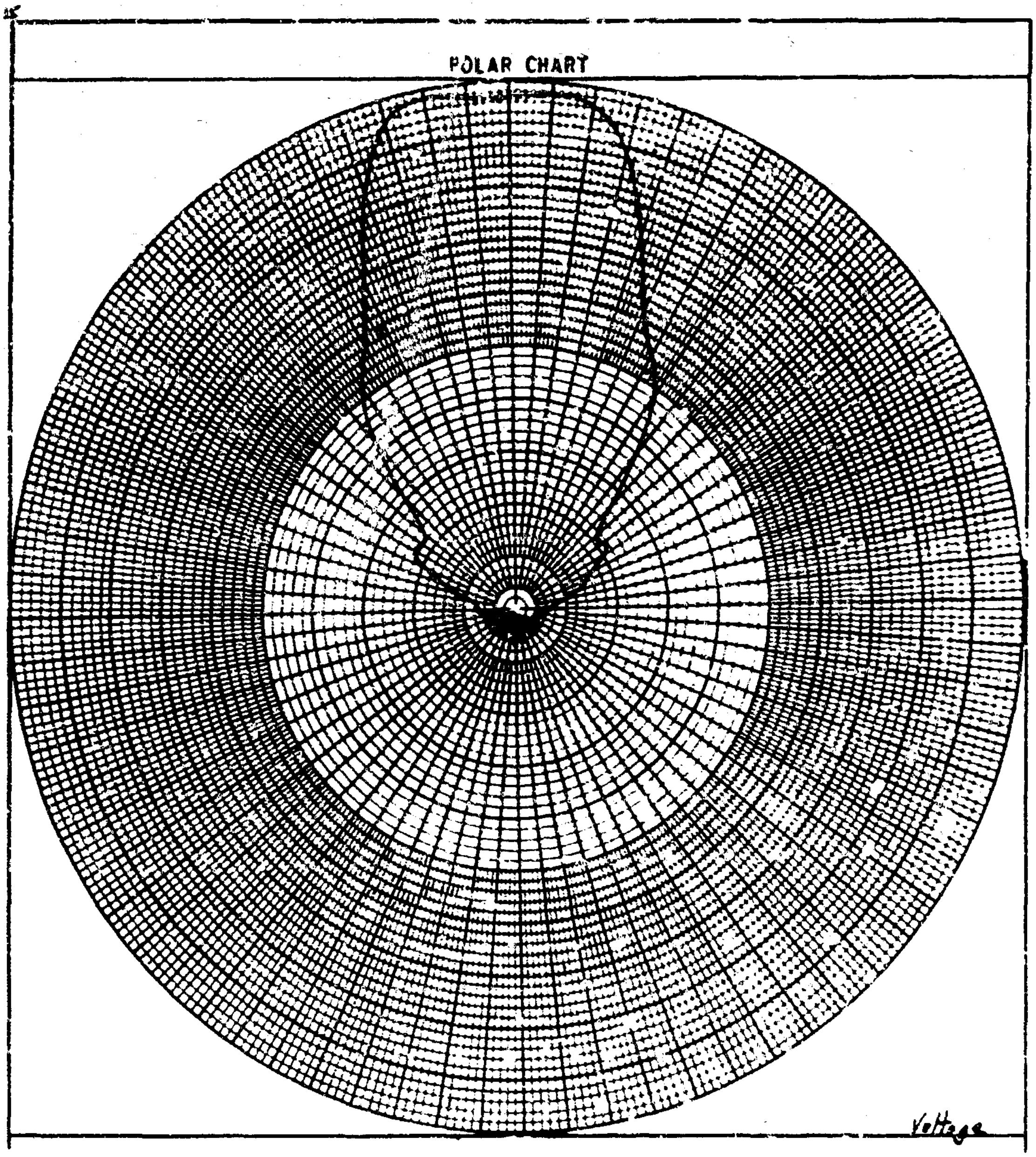
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 55 1.4 GHz E-PLANE



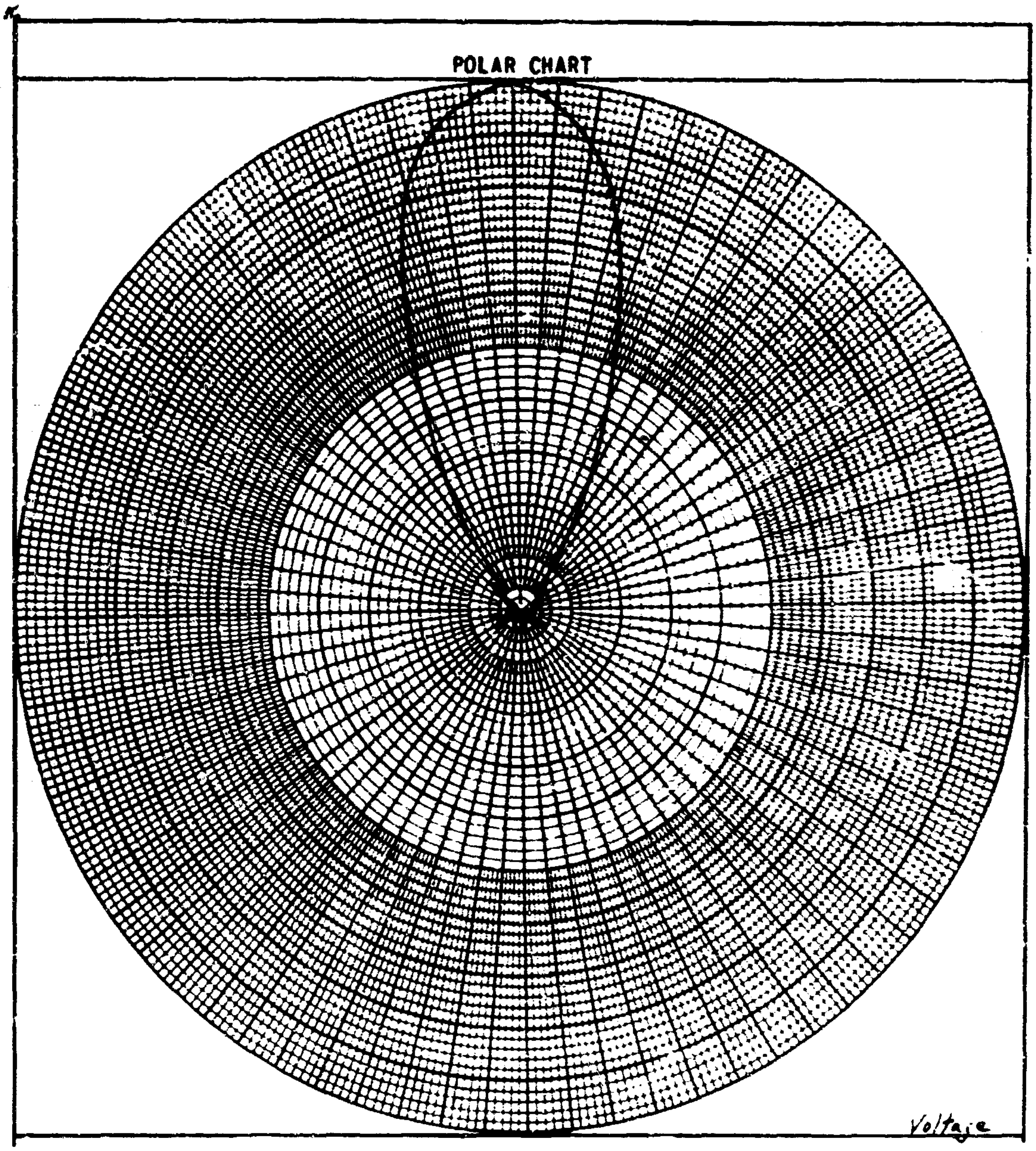
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 56 1.4 GHz H-PLANE



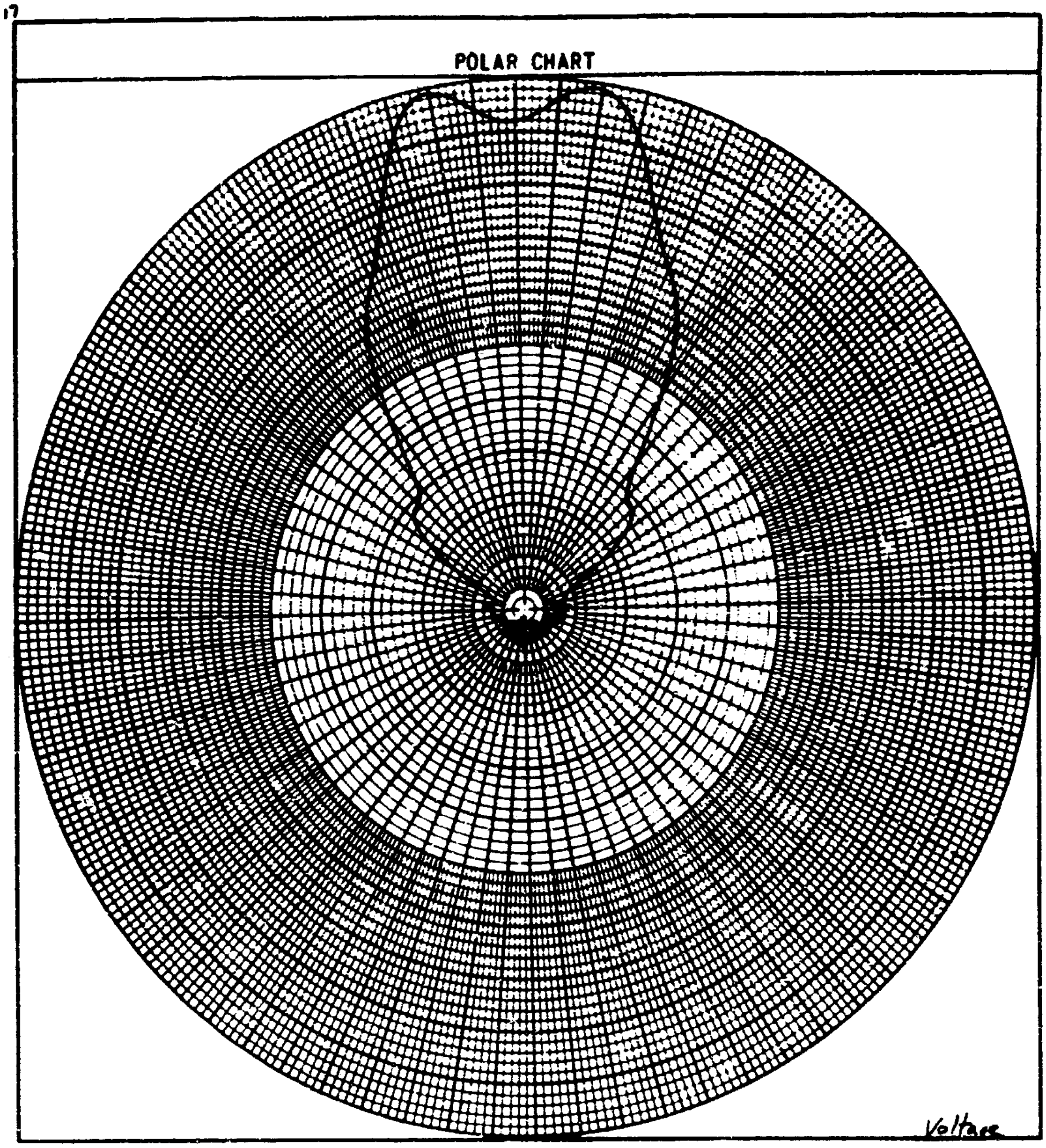
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 57 1.6 GHz E-PLANE



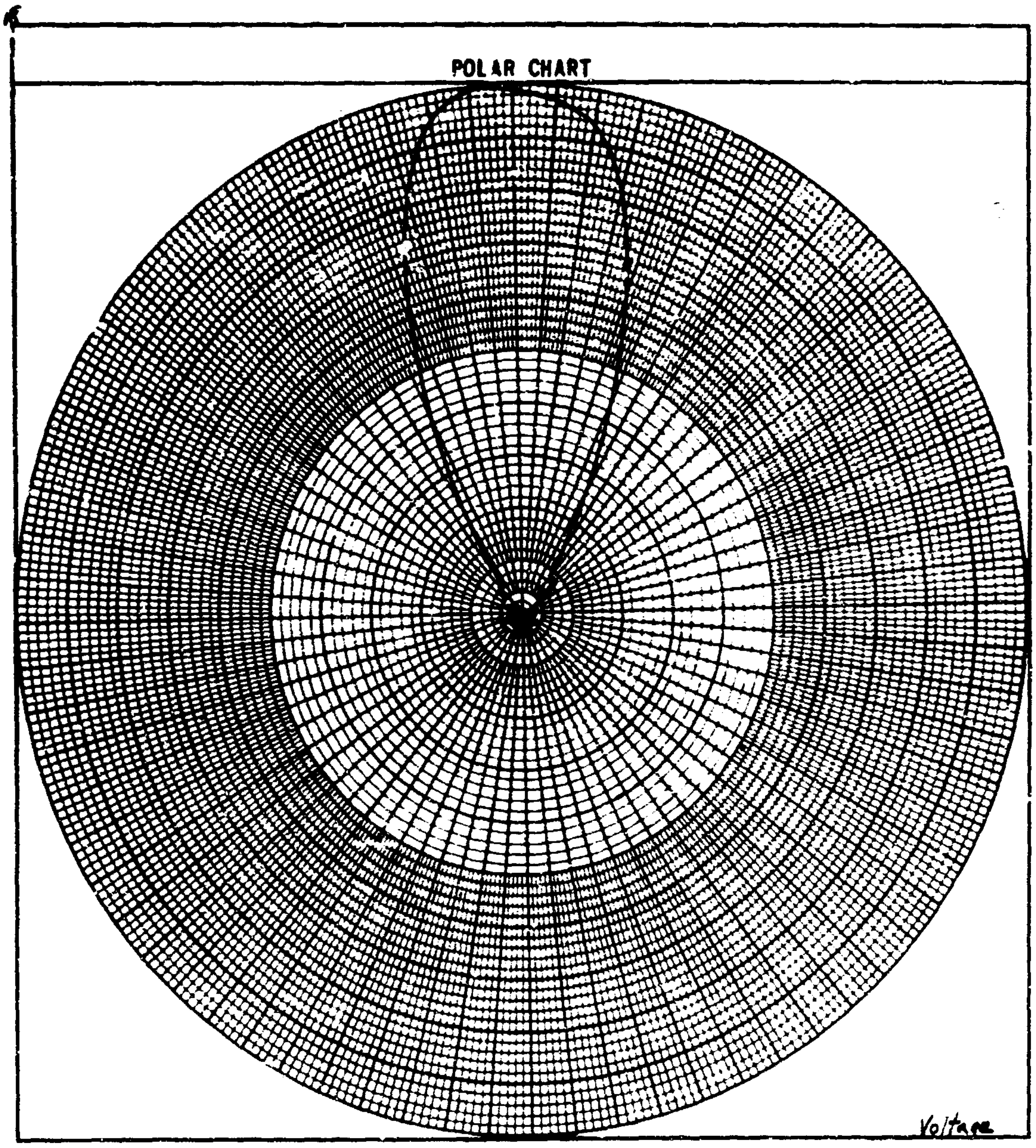
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 58 1.6 GHz H-PLANE



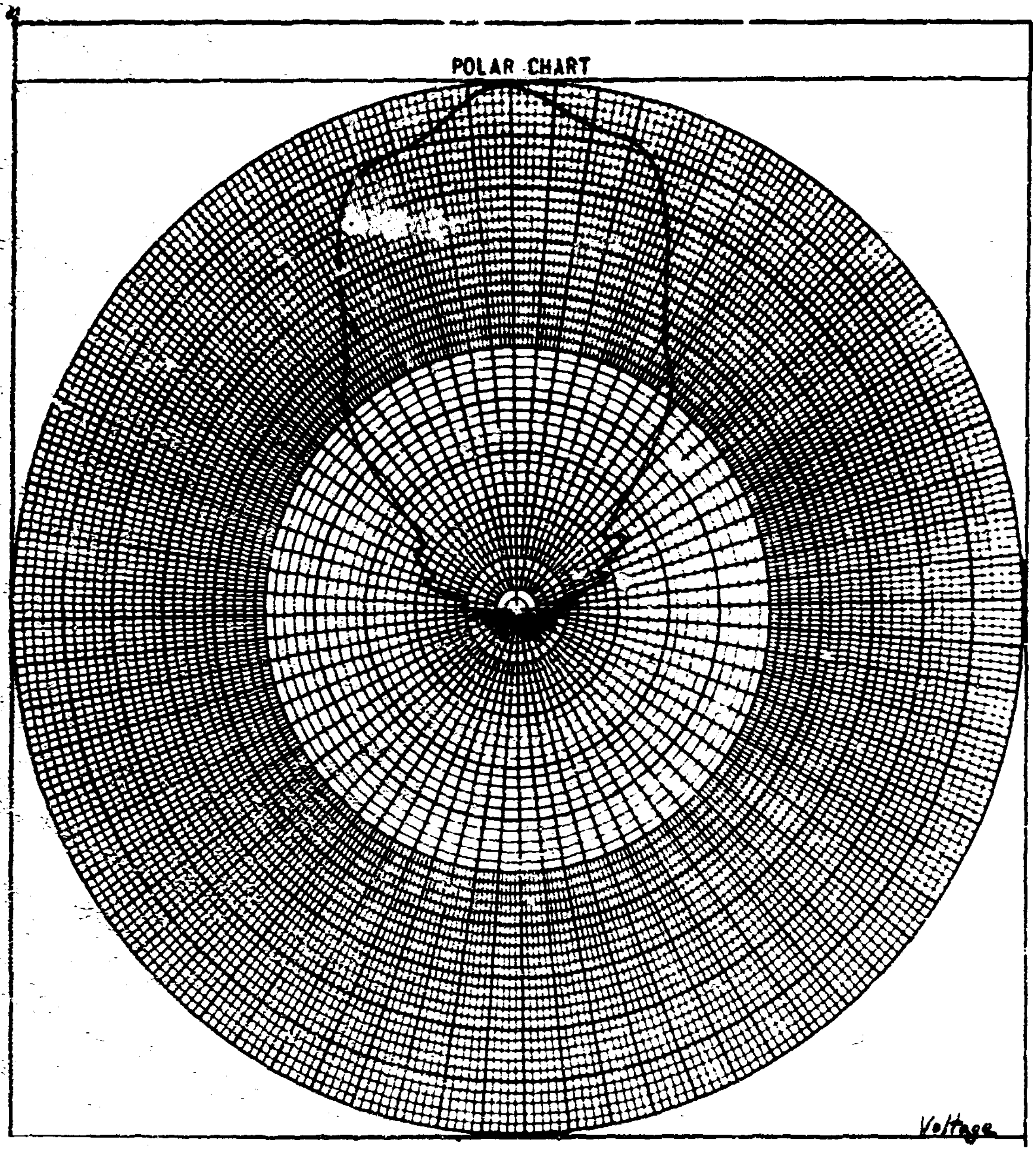
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 59 1.8 GHz E-PLANE



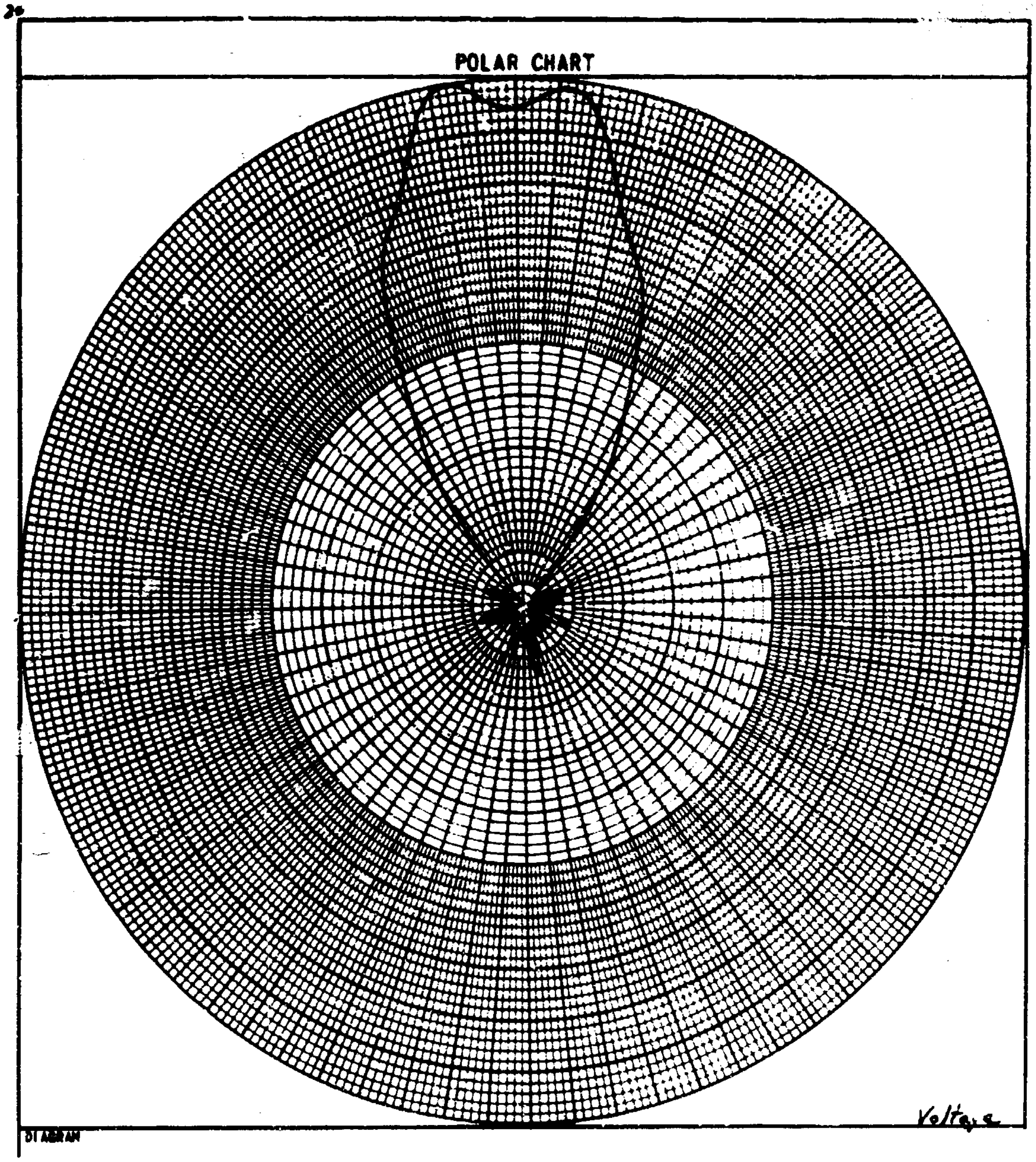
SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 60 1.8 GHz H-PLANE



SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 61 2.0 GHz E-PLANE



SHORT AXIAL LENGTH HORN (0.2 GHz-2.0 GHz)

FIGURE 62 2.0 GHz H-PLANE

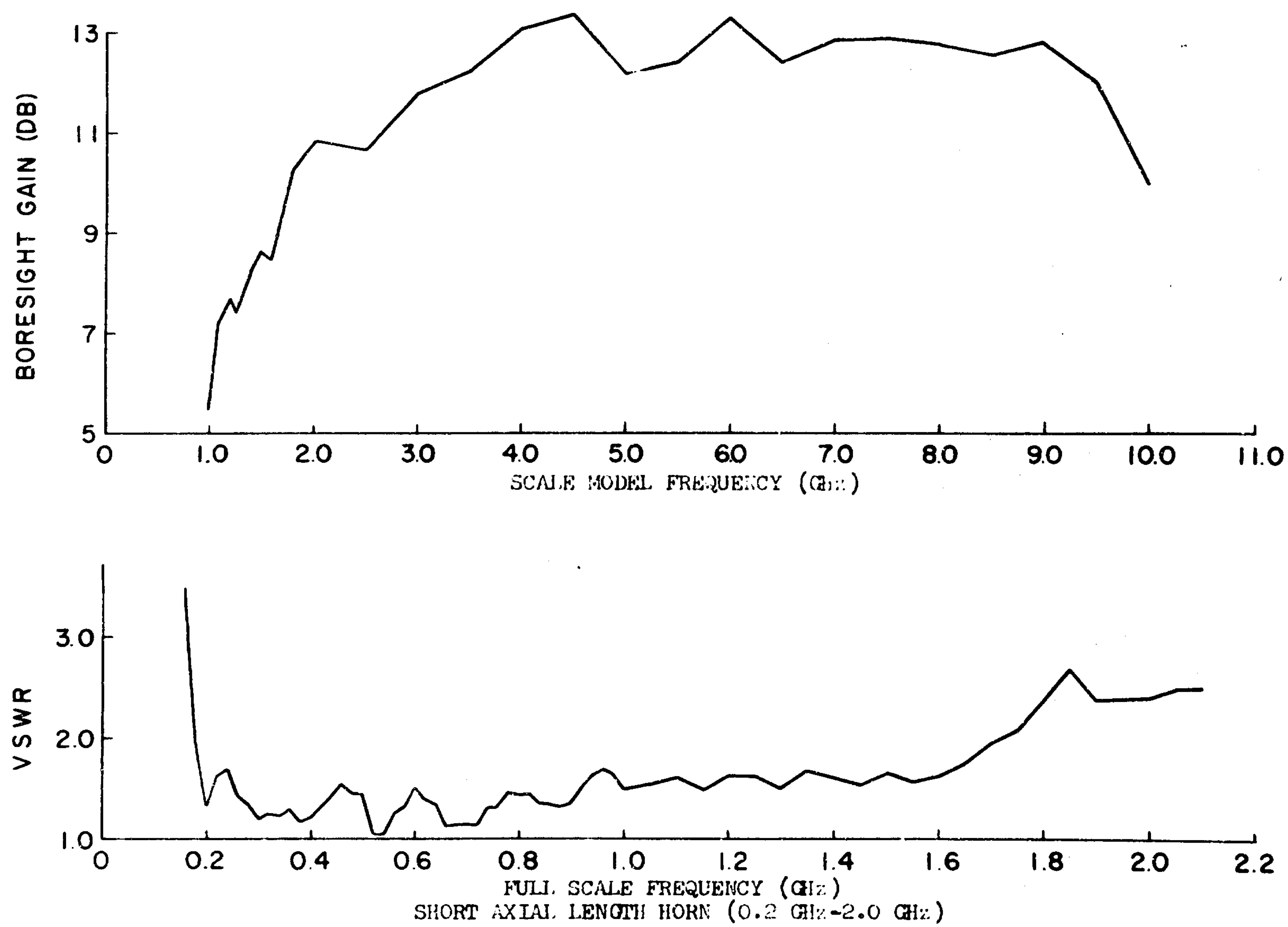


FIGURE 63 - VSWR AND GAIN

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13. ABSTRACT

This report describes the development of two very broadband horns in which a substantial reduction in axial length, over that of earlier models, has been achieved. A significant requirement for both models is that of maintaining the half-power beamwidth greater than thirty degrees over the very broad bandwidths involved.

The first horn developed covers the frequency range from 1 GHz to 12 GHz with the flared portion of the horn having an axial length of six inches as compared with twelve inches for a previous design. The short axial length design was used as a basis in developing a very reasonably sized antenna operating in the range from 0.2 GHz to 2.0 GHz. A technique of fabricating the H-plane walls in the form of a grid was used in both horns as a means of controlling the H-plane patterns. The grid for the 1 GHz to 12 GHz horn was fabricated in printed circuit form while the grid elements of the lower frequency horn were made of aluminum tubing.

Electrical performance characteristics of both models are presented in the form of radiation patterns, VSWR, and gain curves.

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