Aerials for Rebecca in Beaufighter

by

B.F. Cooper
R.B. Coulson

R.P.230 CONFIDENTIAL Copy No. 21

Council for Scientific and Industrial Research
DIVISION OF RADIOPHYSICS

A B S T R A C T

The development of two types of Rebecca receiving aerial for the Beaufighter, one fitted to the wings and the other to the nose, together with transmitting aerial are described. Also included are results of flight tests with Eureka; and installation instructions and diagrams.

BFC:RBC/JAS

28th November, 1944.

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COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
DIVISION OF RADIOPHYSICS

C O N T E N T S

AERIALS FOR REBECCA IN BEAUFIGHTER

By: B.F. Cooper
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PART I
DESIGN OF WING AERIALS

1. INTRODUCTION

A brief outline of the experimental work leading to the development of the wing aerial system for the Australian Rebecca installation on the Beaufighter plane follows.

The aerials are suitable for frequencies of 176 Mc/s and the range from 214-234 Mc/s with satisfactory gain and direction finding properties.

1.1 Requirements

A set of receiving aerials was needed which would be vertically polarised and have the following properties:-

(a) Frequency Band — 176 Mc/s and 214 - 234 Mc/s

(b) Gain — Sufficient gain on upper frequency band to give range of 20 miles in the forward direction at 1500 ft. with Australian Rebecca and Eureka equipment, and 10 miles in the backward direction.

(c) D/F Properties — To give continuously increasing D/F up to 60° without ambiguities with a D/F ratio of about 1.5/1 at 10° off.

(d) Match — A standing voltage wave ratio of less than 2:1 on all frequencies.

(e) Miscellaneous — To be free from propeller modulation.

Requirements (c) and (e) were the considerations which finally led to the adoption of a wing installation as against a fuselage installation. (See Fig. 23)

The transmitting aerial was installed under the nose of the aircraft. It was required to behave similarly in matching qualities as in 1.1 (d) and have suffieient gain to trigger Eureka at 25 miles at least.

2. PRE-EXPERIMENTAL CONSIDERATIONS

It appeared that whatever actual type of aerial were developed, it would probably consist of two or more elements in the form of an array, some elements being either parasites or phased elements. It was decided to pursue the simplest type of aerial with the hope that it could be made workable. Rather than an array of $\frac{\lambda}{2}$ elements such as in, say, a Yagi aerial, $\frac{\lambda}{4}$ elements were used, connected to the underside of the wing with electrical images thus produced in the aluminium covering. The R.A.A.F. had expressed a preference that any installation should be on the underside of the wing rather than on top. This brought in another complication, in that, in addition to the effects that the body of the plane and especially the engine nacelles would have on the polar diagrams, rockets which are installed under the wing could not be permitted to influence the diagram too much.

Solution to the above problem was to produce an aerial with a pattern which had little radiation in the direction of these obstructions: this also helped to minimise propeller flutter.

Another consideration borne in mind during the experimental work was to keep the elements as thin as possible in order to minimise wind drag, and yet thick enough to keep the bandwidth large.

3. EXPERIMENTAL PROCEDURE

All early work on the aerial was done on a "mock-up" wing. This was a flat metallic sheet 6' x 6' mounted on a turntable about 2'6" above the ground. The elements were mounted vertically on the top of tthis and the horizontal diagram taken by rotating the aerial while it received CW signal from a dipole transmitter about 50 yards away. Readings of second detector current were recorded against angle.

3.1 Polar Patterns

Most of the work was first done on 224 Mc/s using an exciter and single director. Various spacings between the elements were tried (.1λ, .15λ, .2λ) together with different lengths of exciter and director. Eventually it was found that an exciter $14\frac{1}{4}$" long with a director $10\frac{3}{4}$" long with a separation of $6\frac{5}{8}$" produced a satisfactory diagram to suit the frequency range 214-234 Mc/s. Then the performance at 176 Mc/s was investigated. It was found that the director decided upon for the higher frequency band produced very little effect at 176 Mc/s, the polar pattern being almost circular. Accordingly, a reflector $16\frac{1}{2}$" long, $6\frac{5}{8}$" behind the exciter was found to work satisfactorily for 176 Mc/s. Again it was noticed that this reflector had only small effect at the higher frequencies. After checking a crude experimental installation on a Beaufort Bomber on the ground, an aerial consisting of the three elements was installed on a Beaufighter. The line of the three elements lay along the axis of the wings, with the exciter about five feet from the wing tip. The matching of this aerial will be described later. The polar patterns for this first installation are shown in Figs. 1, 18 and 19.

3.2 Result of First Flight Test

After a flight test, it was found that this aerial had far too little gain, in that the range was only 15 miles.

Work then proceeded to develop higher gain. This time, the aim was to produce as much gain as possible at upper frequency band, temporarily forgetting about the 176 Mc/s point. Accordingly an experimental "mock up" was made on the 6' x 6' metallic sheet with the lengths and positions of director and reflector continuously variable. The exciter was left the same since it had been found to be best from considerations of match. The aerial then produced was as follows:-

Exciter	= $14\frac{1}{4}$"
Reflector	= 12"
Director	= $10\frac{3}{4}$"
Exciter--Reflector distce	= $15\frac{1}{8}$"
Exciter--Director distce	= $10\frac{1}{2}$"

The gain along the direction of greatest intensity i.e. along the line of the elements, was measured in comparison with a standard matched dipole for each frequency.

With the dimensions fixed for maximum gain, polar patterns were taken at 214, 224 and 234 Mc/s on the "mock up" platform and were found to be much sharper than those of the first trial installation. A sample pattern at 224 Mc/s is shown in Fig. 2.

After studying the patterns and with an eye to greater forward gain, it was decided that, without sacrificing too much of the D/F properties, the main beam could be swung round to 45° from straight ahead direction on the 'plane. Assuming this then, and that the engine nacelles etc. would not cause much damage, work was started on 176 Mc/s. Since gain was not such an important factor for use with Beacon, attention was concentrated on modifying the pattern so that it would have, above all good D/F characteristics on 176 Mc/s. Accordingly, a fourth element was added -- a parasitic reflector -- at 45° to the line of the other elements. This tended to shoot the beam out sideways and increase the sharpness of cross-over dead ahead at 176 Mc/s.

This parasite was tuned both in length and distance of separation from the exciter and a complete set of polar patterns at all frequencies was taken. These are shown in Figs. 3, 4, 5 and 6. It was now considered that for this simple type of aeria the best possible performance was being got out of it.

4. PERFORMANCE OF AERIAL

4.1 Gain

Before the second reflector was added, gain measurements were taken (in the optimum direction) and were:-

FREQUENCY	GAIN REL. TO STD. DIPOLE
214 Mc/s.	$5\frac{1}{4}$ db.
224 "	5 db.
234 "	$5\frac{1}{2}$ db.

The reason for maximum gain being at 234 Mc/s. was that the geometry of the aerial was decided on that frequency.

The addition of the second reflector served to increase these gain figures despite the "squint" given to the patterns as can be seen in Figs. 4, 5, and 6. Still measuring gain along the line of the three higher frequency elements, and with the 176 Mc/s reflector in place, the following results were obtained

FREQUENCY	GAIN REL. TO STD. DIPOLE
214 Mc/s.	5½ db.
224 "	5½ db.
234 "	6½ db.

D/F ratios obtained from Figs. 3, 4, 5 and 6 are plotted in Fig. 7.

4.2 Effect of Aeroplane Structure

It now remained to see whether the aeroplane structure did anything serious. Therefore a sheet of steel 3' x 3' with the elements attached in their correct positions was strapped to the underside of the wing of a Beaufighter. Polar patterns obtained under these conditions with line of three upper frequency elements making 45° with line of flight are shown in Figs. 8, 9, 10 and 11 for frequencies 176, 214, 224 and 234 Mc/s.

Derived D/F characteristics for this set up are plotted in Fig. 12.

These results indicated that the whole array could be safely rotated even more to the front, thus increasing head on gain but perhaps destroying the D/F properties. Accordingly the array was swung through a further 20° which gave almost 3 db. more gain and still performed satisfactorily. Polar diagrams are plotted in Fig. 13, and D/F ratios in Fig. 14. All work on the 'plane on the ground was done with the tail of the plane lifted up, so that, except for the wheels, the plane was in the flying position. This proved to be a well worthwhile precaution.

5. MATCHING DEVICE

The work on polar patterns described above was continuously interspersed with impedance measurements. Thus the final lengths of the elements, particularly of the exciter, were decided by means of impedance checks. Taking measurements at the feedpoint of the aerial, the length of the exciter was tuned to 176 Mc/s, i.e. it was adjusted until at 176 Mc/s, the measured impedance was resistive. The impedances for the other frequencies is shown in Fig. 15. The exciter element was made of 1" tube compressed to approximate to elliptical cross-section. This is thicker than the parasites and was adopted for reasons of bandwidth. A thinner element proved to be too critical with frequency. The parasites were made from ¾" round tube similarly compressed, the smaller size being allowable in that the parasites had a comparatively smaller effect on the bandwidth. It is to be noted that impedance matching was done on the first, or 3-element, array before it was noticed that this system lacked in gain. Fortunately, however, it was discovered that the matching device evolved for this system was fairly good for the second, or 4-element array. The cable feed adopted was Uniradio No. 1 with characteristic impedance 75 ohms.

A study of Fig. 15 indicated that some sort of $\lambda/4$ transformer might possibly bring the 176 Mc/s impedance up within the 2:1 mismatch circle and yet not disturb the impedances at higher frequencies too much.

Also it was noticed that $\frac{3}{4}\lambda_{176} = \lambda_{234}$, so that a length of line cut at a length equal to λ_{234}, while not effecting impedance at 234 Mc/s, would act as a $\lambda/4$ transformer at 176 Mc/s, and only slightly change the impedances at 214 and 224 Mc/s. The impedance at 176 Mc/s was $13\frac{1}{2}\Omega$.

For a $\lambda/4$ length of line of characteristic impedance Z_o, terminated by an impedance Z, the "looking in" impedance, $Z_{IN} = \frac{Z_o^2}{Z}$. So that to match $Z(= 13\frac{1}{2}\Omega)$ to cable of 75Ω impedance, Z_o can be obtained thus:-

$$Z_o = \sqrt{Z\ Z_{IN}}$$

$$= \sqrt{13\tfrac{1}{2} \times 75}$$

$$= 32\Omega$$

This is almost met by two lengths of Uniradio No. 1 in parallel, giving a $Z_o = 37\frac{1}{2}\Omega$. Such a transformer was made up and tried. Fig. 16 shows the new impedances. Though the impedances do not fulfil theoretical expectations, they are satisfactory as the S.W.R. is always 2/1 or less.

The standing wave ratios when this type matching device was applied to the 4-element array are shown in Fig. 17.

6. CONCLUSION

Photographs (Figs. 20, 21) of the final aerial installation are included.

While the characteristics seem satisfactory as measured on the ground, they proved even better during actual flight tests. Full details of flight tests are given in Part III.

PART II

DESIGN OF NOSE AERIAL

1. INTRODUCTION

The standard British fuselage mounting Rebecca aerial when tried on the Beaufighter gave an unsatisfactory polar diagram due to the unusually short nose of this aircraft. Further, an increase in power gain was desirable to give a greater margin of range performance. The nose aerial described herein, while representing a considerable improvement on the fuselage aerial is still inferior to the wing aerials which were developed simultaneously (See Part I).

2. EXPERIMENTAL PROCEDURE

2.1 Characteristics of Fuselage Aerials

Prior to work on the Beaufighter at Radiophysics, the R.A.A.F had fitted a set of British aerials in the position shown in Fig. 23. On the average aircraft this aerial gives a prominent lobe on the side on which the aerial is mounted and a fairly sharp cut off on the other side due to the screening effect of the fuselage. This results in a good D/F characteristic with the D/F ratio increasing rapidly as the aircraft goes off course to either side.

However, in the case of the Beaufighter the engine nacelles are so prominent that the port nacelle, for instance, cuts off the radiation from the port aerial beyond 50° off the line of flight and produces a big dip in its main lobe. On the other hand a proportion of the energy from the starboard aerial is reflected from the starboard nacelle and produces a large secondary lobe on the port side. The nett result is that the D/F ratio starts off in the right way but soon decreases to 1/1 again as shown in Fig. 24. This diagram is not acceptable since it may lead to confusion in homing and indeed the R.A.A.F. has specified that the D/F ratio must increase progressively out to 60° off the line of flight.

Further work was therefore undertaken and the nose aerial was evolved as described in the next section.

2.2 Design of Nose Aerial

In order to improve on the fuselage aerial various arrangements of dipole with director were tried around the nose and it was found practically impossible to avoid the cut off due to the nacelles until the aerial was nearly in front of the nose. At this point, however, there was a very poor cross-over characteristic although the forward gain was improved 4-5 db. The addition of a reflector rod produced a reasonably good cross-over but since all the parasitic elements were tuned to 224 Mc/s the 176 Mc/s diagram was very poor. Finally, a 176 Mc/s reflector was placed near the 224 Mc/s reflector and although the operation on 176 Mc/s still left much to be desired, it was felt that this was the best that could be done in the time available and without a further increase in the complexity of the aerial. A "flyable" model of the aerial shown in Fig. 22 was made up using the fuselage aerials as an expedient. It will be seen that the reflector rods function for both the port and starboard aerials and possibly prevent interaction between the exciter elements. The Uniradio No. 4 feeder (47 ohms) used in the British aerial was replaced by Uniradio No. 1 (75 ohms), the standard local cable.

2.2.1 Polar Diagrams

Polar diagrams taken on the ground with the tail up in the flying position are given in Figs. 25 and 26 and D/F ratios are derived from the polar diagrams in Fig. 27 and 28. These may be compared with the D/F ratios observed in flight as shown in Fig. 29.

2.2.2 Propeller Effects

During the taking of polar diagrams it was observed that the propellers had a considerable effect on the aerials, and the readings at each bearing were taken with the propellers in the position which gave maximum reception. This corresponds to the observation in flight where the observer naturally concentrates on the outermost of the multitude of "blips" which are produced by the rotating propeller.

At this juncture it might be mentioned that the propeller modulation does not seriously affect D/F-ing if attention is concentrated on the outermost "blips" although the effect is quite unpleasant and the wing aerials are much to be preferred for their freedom from propeller effects.

2.3 Impedance Measurements

The impedance at the feed point of the aerial is given in the following table. No attempt was made to devise a transformer which would correct the impedance at 176 Mc/s.

FREQUENCY	S.W.R.	$\frac{R}{Z_o}$*	$\frac{X}{Z_o}$
176 Mc/s	3.3	.75	-1.05
214 "	1.78	1.08	+ .6
224 "	1.34	.85	- .22
234 "	1.5	1.14	+ .42

* $Z_o = 75\Omega$

3. CONCLUSIONS

From all points of view it seems that Rebecca receiving aerials on the fuselage or nose of the Beaufighter are, at best, only a compromise and the wing aerials should be adopted unless some unforseen mechanical objection precludes the use of the latter. A further objection to the nose aerials is the difficulty of finding another position for the camera which usually is mounted in the nose.

PART III
REBECCA-EUREKA FLIGHT TRIALS
28:10:44 and 3:11:44

1. INTRODUCTION

The above trials were carried out to determine the performance of what is hoped will be the final versions of Rebecca IIB (Aust.) and Eureka IIB, prior to handing the prototype over to R.A.A.F. for acceptance trials. In previous trials some difficulty had been experienced in achieving the specified range of 20 plus miles at 1500 ft., and at the same time providing an aerial system for the Beaufighter which would give satisfactory D/F.

Of the two aerial systems then fitted, only the fuselage aerials were giving the required range but their D/F ratio decreased to approximately unity for angles beyond 50° off the line of flight. A set of aerials fitted under the wings had very satisfactory D/F properties but their power gain was low resulting in a range of only 15 miles.

Further work on the latter aerials has resulted in an increase of 10 db. in their forward power gain so that they now give the required range, while a new design of aerial has been fitted to the nose which gives the same range performance but has only fair D/F properties.

2. RESULTS

The flight results are tabulated below. Eureka was set up on Bankstown aerodrome, its aerial height being 10 ft. The aerial used was a copy of the AN-PPNI design mounted on the R.P. tripod, and the R.P.-designed aerial, which is not quite as efficient, was also given a short trial for comparison

2.1 Maximum Ranges (Reception of beacon)

Aircraft Height	Course	Frequency Channel	Beacon Aerial	Range n miles	S/N
1500'	140°	AC'	PPN-1	18 tail on	$1\frac{1}{2}$:1
"	320°	"	"	27 head on	"
"	140°	CE'	"	20 tail on	"
"	320°	"	"	27 head on	"
"	140°	EA'	"	22 tail on	"
"	320°	"	"	20 head on*	5:1
"	090°	PP'	Mascot A.S.V. Beacon	25 head on	2 or 3:1

*On turning back at 30 miles the receiver became unstable for some obscure reason and did not right itself until the distance had closed to 20 miles. At this distance the blip was very strong and it is reasonable to assume that a range of 27 miles would have been obtained if the receiver had not misbehaved.

A couple of runs on frequencies AC' and CE' with the R.P. model of Eureka aerial gave ranges of 21 and 22 miles respectively but it is felt that the beacon was somewhat off tune with this aerial and that it does not compare quite so unfavourably with the AN-PPN-1 design.

Owing to cloudy conditions at 5000 ft. it was not possible to get maximum ranges at this height. This will be done later and it is reasonable to expect a range of approximately 50 miles judging from the proportionality between previous flights at 5000 and 1500 ft.

2.2 Maximum Triggering Range

By keeping a time log on the ground and in the aircraft it was deduced that the maximum triggering range was on the average very close to the maximum range of visibility of the "blip".

2.3 D/F Patterns

These were taken by flying the aircraft on a course of 000° passing slightly to the side of the beacon. The bearing of the beacon from the aircraft was then measured with an astro-compass and D/F ratios were noted. The results are plotted in the attached Figs. 30 and 31. In the case of the 176 Mc/s frequency where Rebecca is normally used to home on to an A.S.V. beacon, anomalous results were obtained due to the reception of horizontally polarised waves on a vertical aerial. When homing on to the Mascot beacon it was found that there was no definite

1:1 D/F position but that actually the D/F ratio oscillated in a rather vague manner between 1:1 and 2:1 for angles up to 60° off course. A small degree of banking produced quite a large increase in amplitude of the "blips" together with a considerable improvement in their appearances indicating that the aerials when vertical only pick up stray radiation. On the other hand the D/F patterns obtained with a vertical aerial attached to Eureka are quite normal as shown in Figs. 30 and 31.

It is suggested that D/F-ing on the A.S.V. beacon may be improved by radiating a small proportion of the energy with vertical polarisation. This could be achieved by clamping small rods on the "cartwheel" aerial as shown in Fig. 32. The size of the rods would have to be adjusted empirically to give a vertical field strength equal, say, one half to one third of the horizontal field.

3. CONCLUSION

From the point of view of getting the best presentation the wing aerials are greatly superior to the nose aerials owing to their smoother D/F properties and freedom from propeller flutter which affects the nose aerials very badly. It would seem, therefore, that the wing aerials should be adopted.

PART IV

INSTALLATION DATA

Drawings of the wing aerial installation are attached as shown in the following list.

B8411	Assy. Dwg. K126
Component Parts List	Nos. 8397
	8435
Detail Dwgs.	See above C.P.L.'s

In the case of the nose aerial, no finished drawings are available, but a sketch (Fig. 25) showing positions of the elements is included.

PART V

TRANSMITTING AERIAL

1. INTRODUCTION

The transmitting aerial is required to radiate the Rebecca transmitter power with a fairly uniform distribution, although a certain amount of reduction in the backwards radiation is tolerable. For the Beaufighter installation a combination of exciter plus director is used, similar to the standard British installation except for mechanical details.

2. EXPERIMENTAL DETAILS

Originally a single vertical element was mounted under the nose to serve as transmitting aerial. It was identical in construction and feed with the wing exciter element described in Part I. However, with the improvement of the receiving aerials it was thought desirable to increase the gain of the transmitting aerial and a director element was accordingly added. The director element is $10\frac{3}{4}$" long and is identical with the directors used on the wing. A sketch of the aerial arrangement is shown in Fig. 33.

3. IMPEDANCE MEASUREMENTS

As mentioned previously, the matching arrangement described in Part I was used on the exciter element, but while this gave a fairly good match it was found that the Rebecca transmitter was inclined to execute a frequency jump in the neighbourhood of 214 Mc/s. By lengthening the exciter element to $15\frac{1}{2}$" and using a single Uniradio No. I feeder without a transformer, a good match was secured at 214 Mc/s with a reasonable match at other frequencies and the frequency jump was eliminated. A table of impedances is given below.

FREQUENCY	S.W.R.	$\frac{R}{75}$	$\frac{X}{75}$
176 Mc/s	1.8	.6	- .25
214 "	1.1	0.95	-0.1
224 "	1.6	1.6	-0.1
234 "	2.2	2.1	-0.4

Exciter length = $15\frac{1}{2}$"

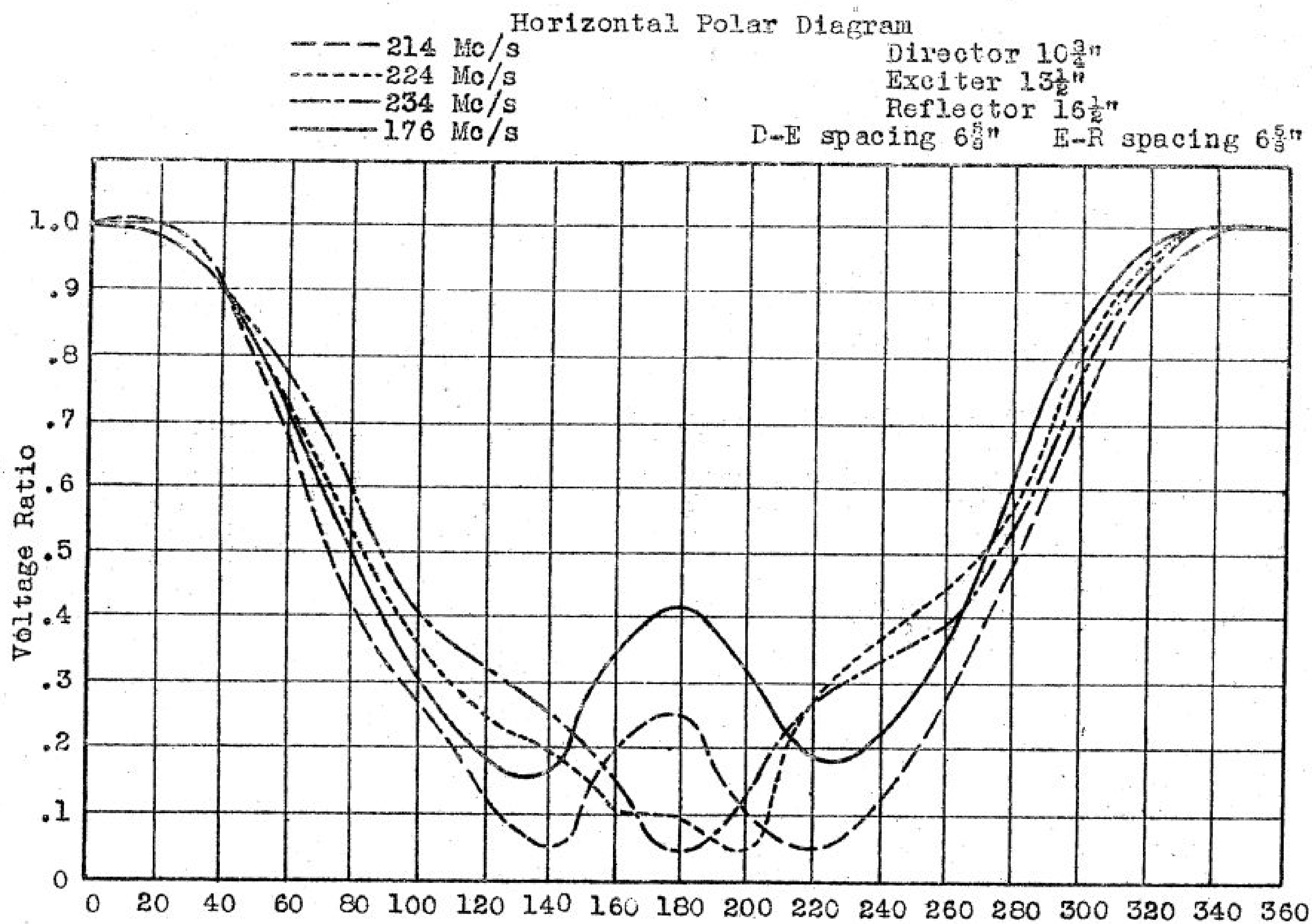

Horizontal Polar Diagram
214 Mc/s
224 Mc/s
234 Mc/s
176 Mc/s
Director 10¾"
Exciter 13½"
Reflector 16½"
D-E spacing 6⅝"
E-R spacing 6⅝"
Voltage Ratio
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360

Fig. 1.

HORIZONTAL POLAR PATTERN FOR 3-ELEMENT ARRAY ON ARTIFICIAL WING. FREQUENCY = 224 Mc/s.

GAIN = 5 db

GEOMETRY:-

EXCITER LENGTH = 14¼

REFLECTOR " = 12"

DIRECTOR " = 10¾"

REFLECTOR-EXCITER SPACING = 15⅛"

EXCITER-DIRECTOR " = 10½"

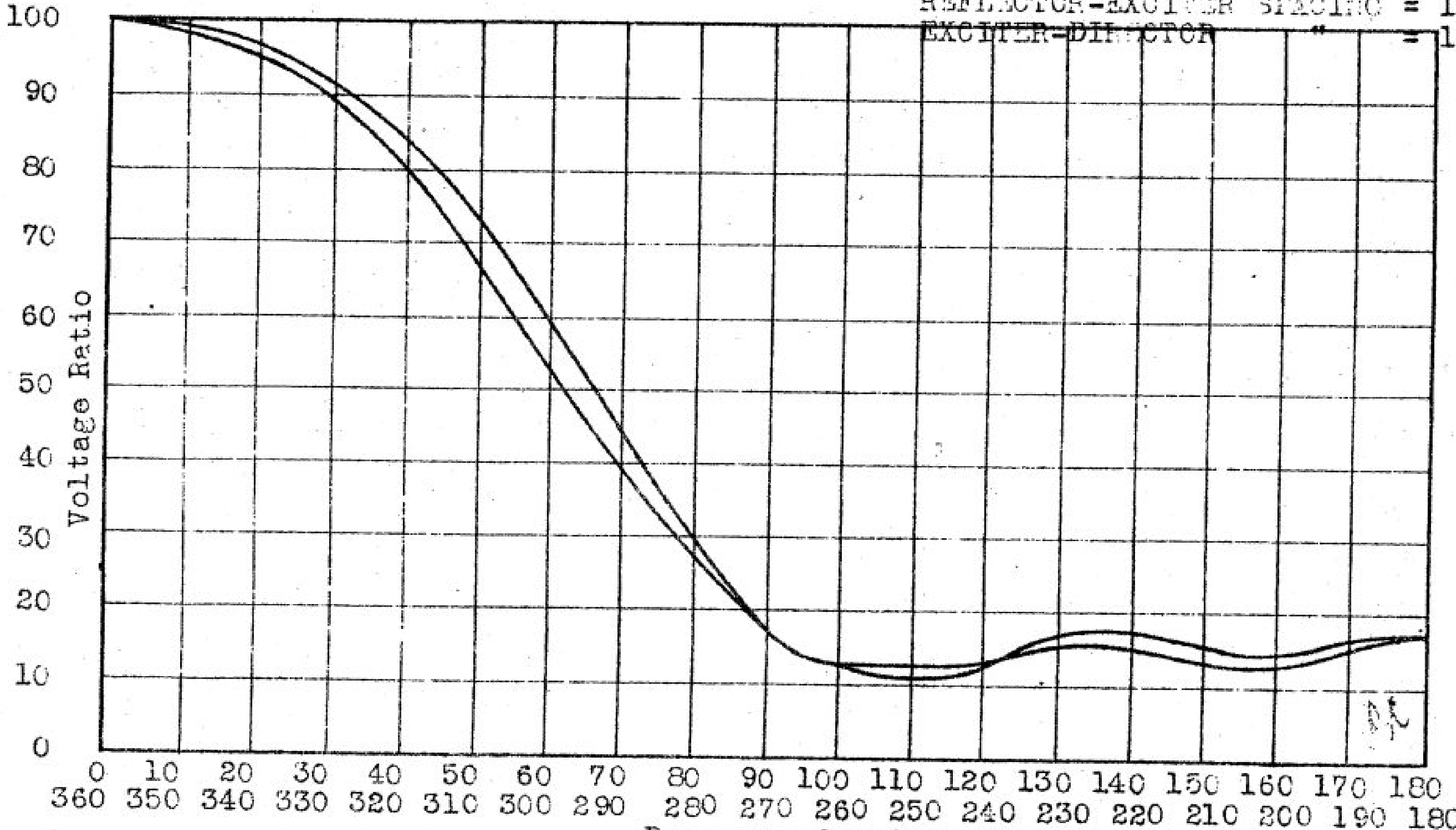


Fig. 2.

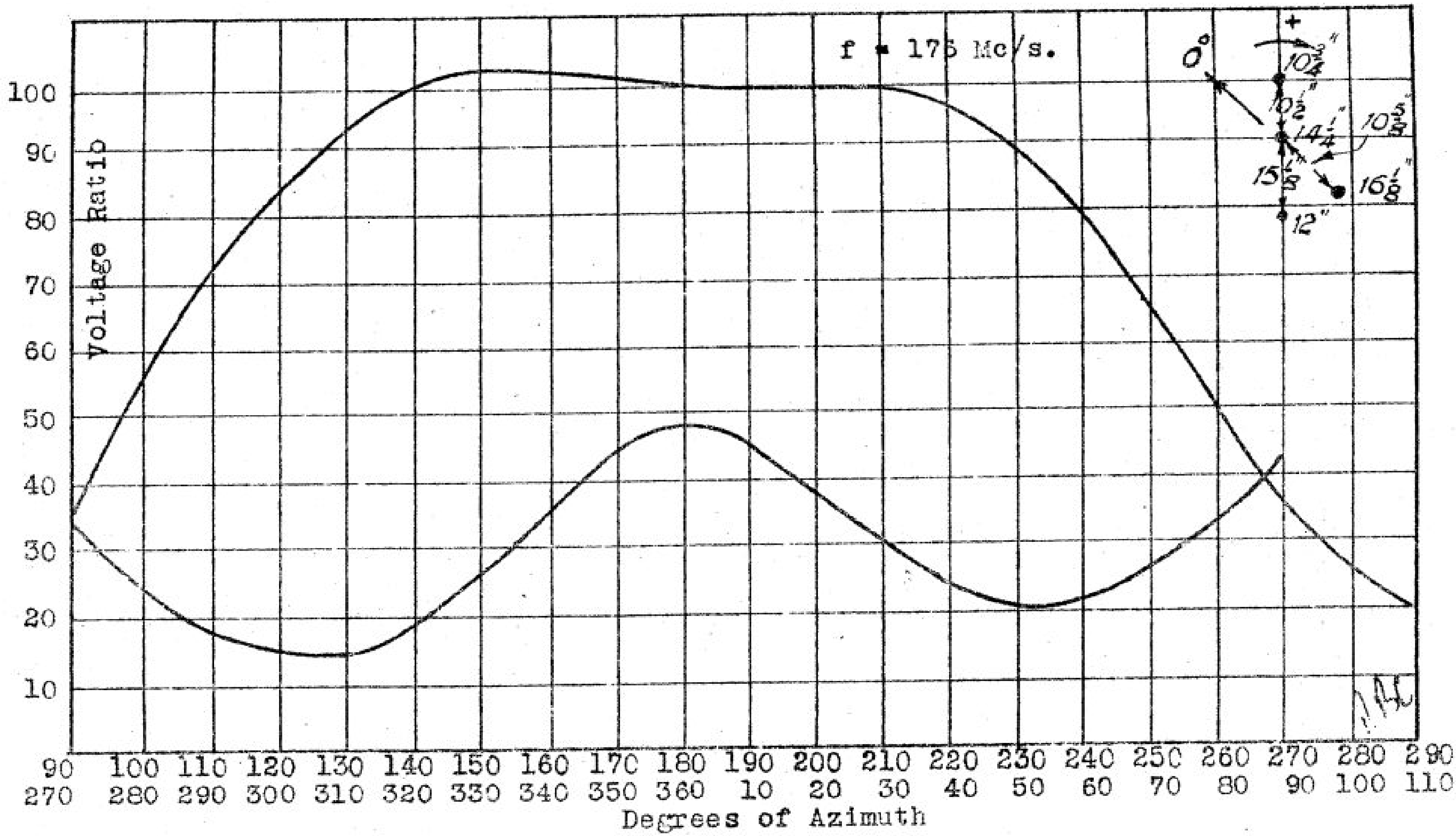
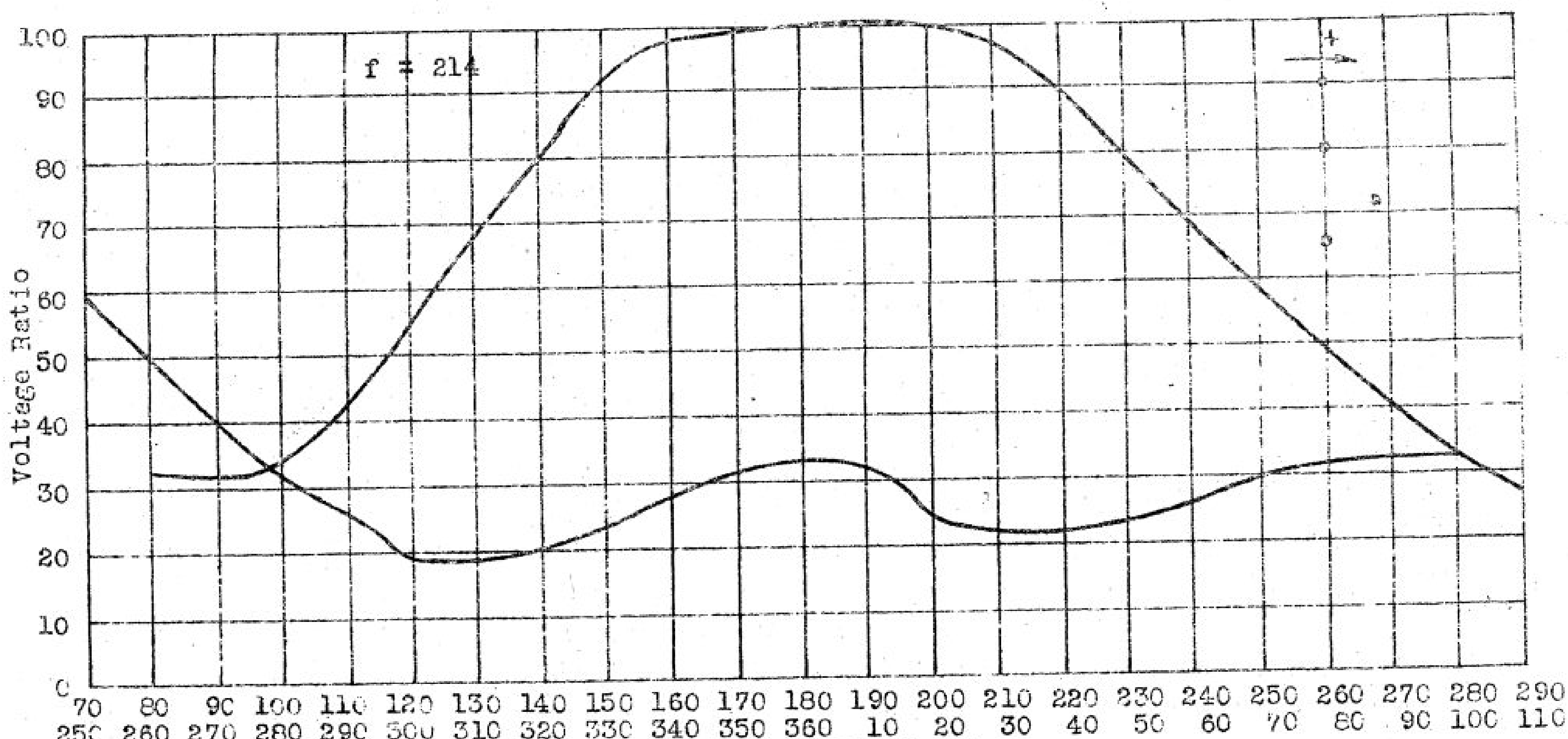

f = 175 Mc/s.
Voltage Ratio
100
90
80
70
60
50
40
30
20
10
90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290
270 280 290 300 310 320 330 340 350 360 10 20 30 40 50 60 70 80 90 100 110
Degrees of Azimuth
0°
+
12"

Fig. 3.



Degrees of Azimuth

Gain = 5½ db

Fig. 4.

f - 224 Mc/s.

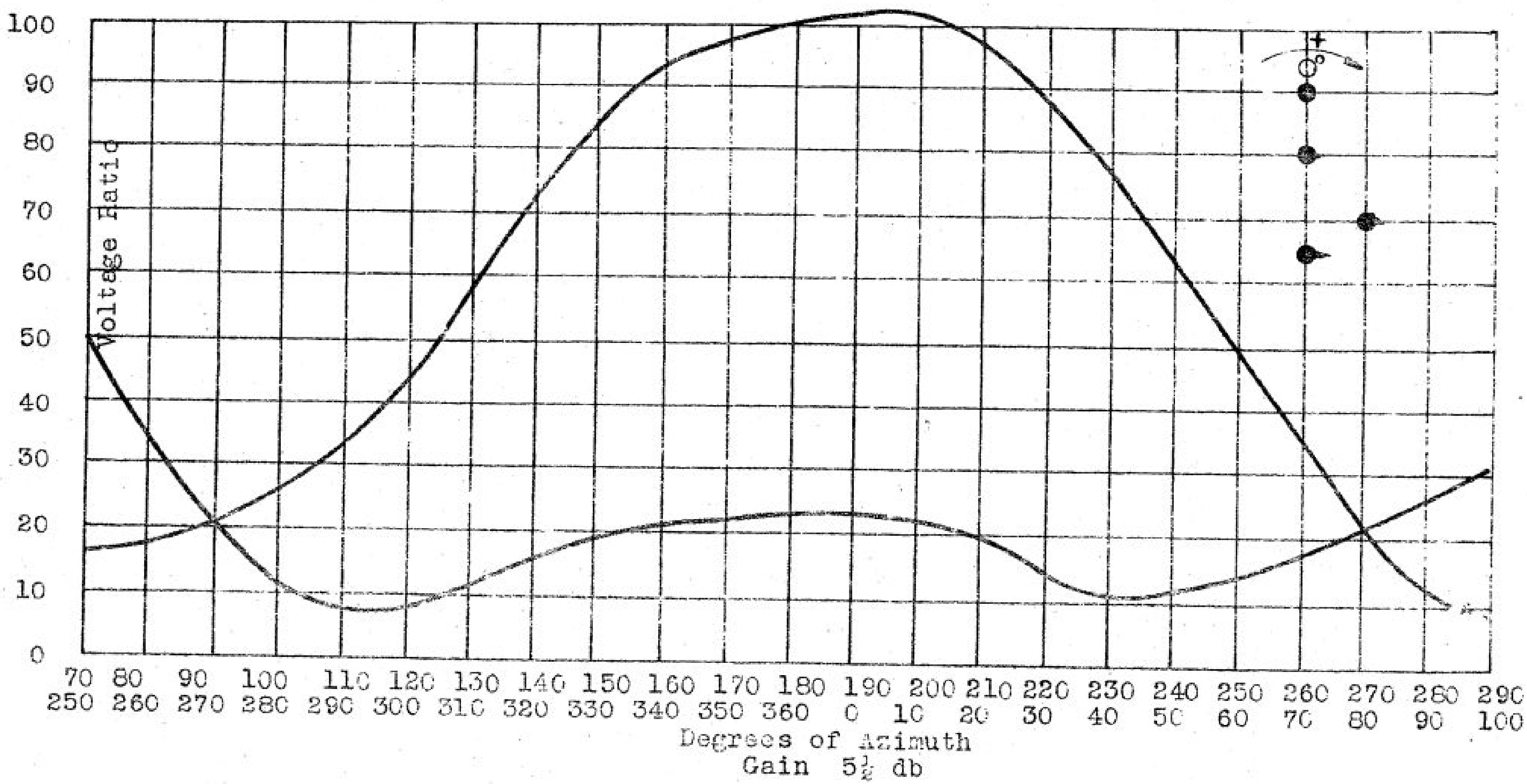
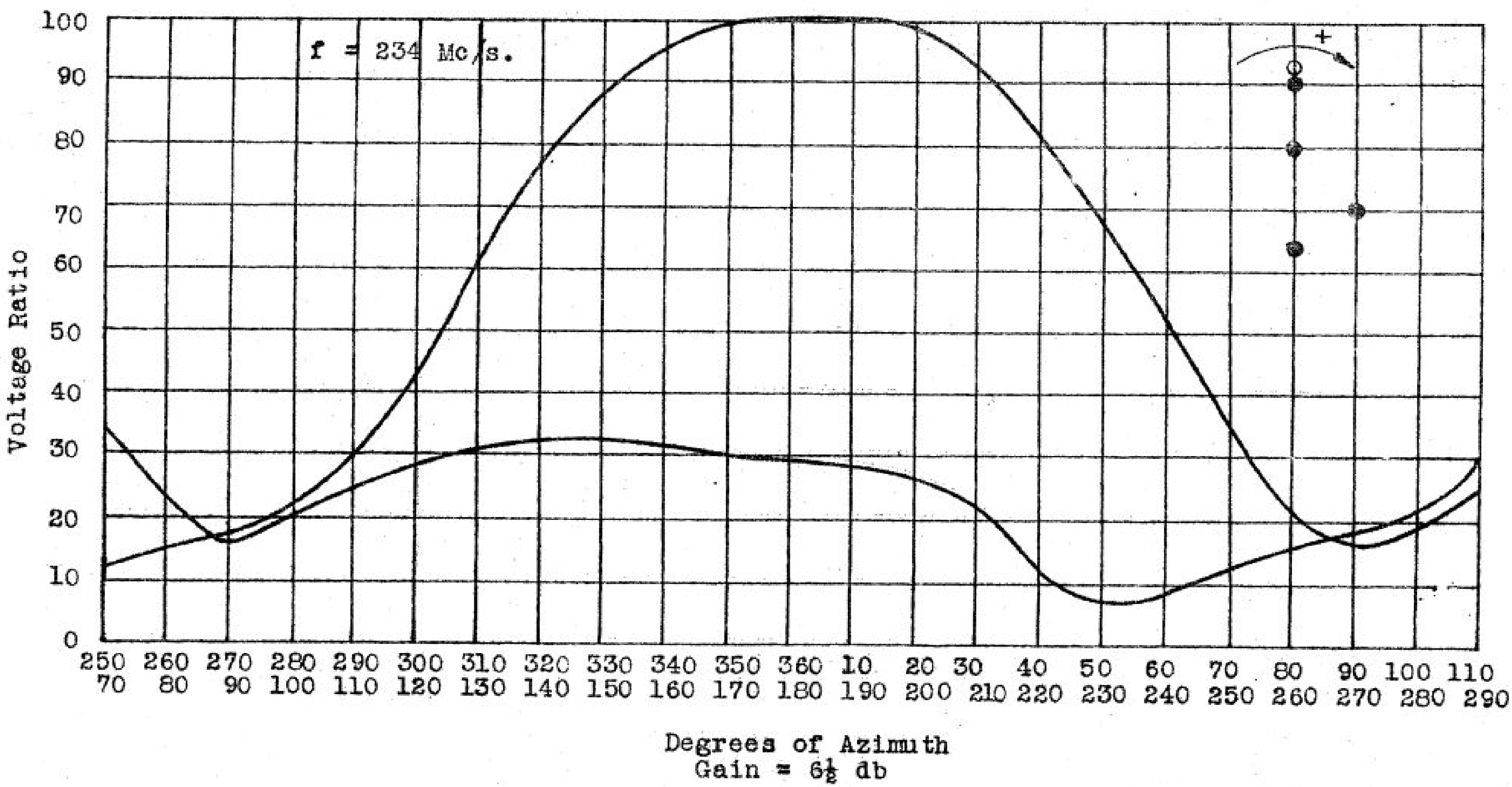


Fig. 5.



f = 234 Mc/s.
+
Voltage Ratio
100
90
80
70
60
50
40
30
20
10
0
250 260 270 280 290 300 310 320 330 340 350 360 10 20 30 40 50 60 70 80 90 100 110
70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290
Degrees of Azimuth
Gain = 6½ db

Fig. 6.

D.F. CHARACTERISTICS OF 4-ELEMENT AERIAL

ON ARTIFICIAL WING

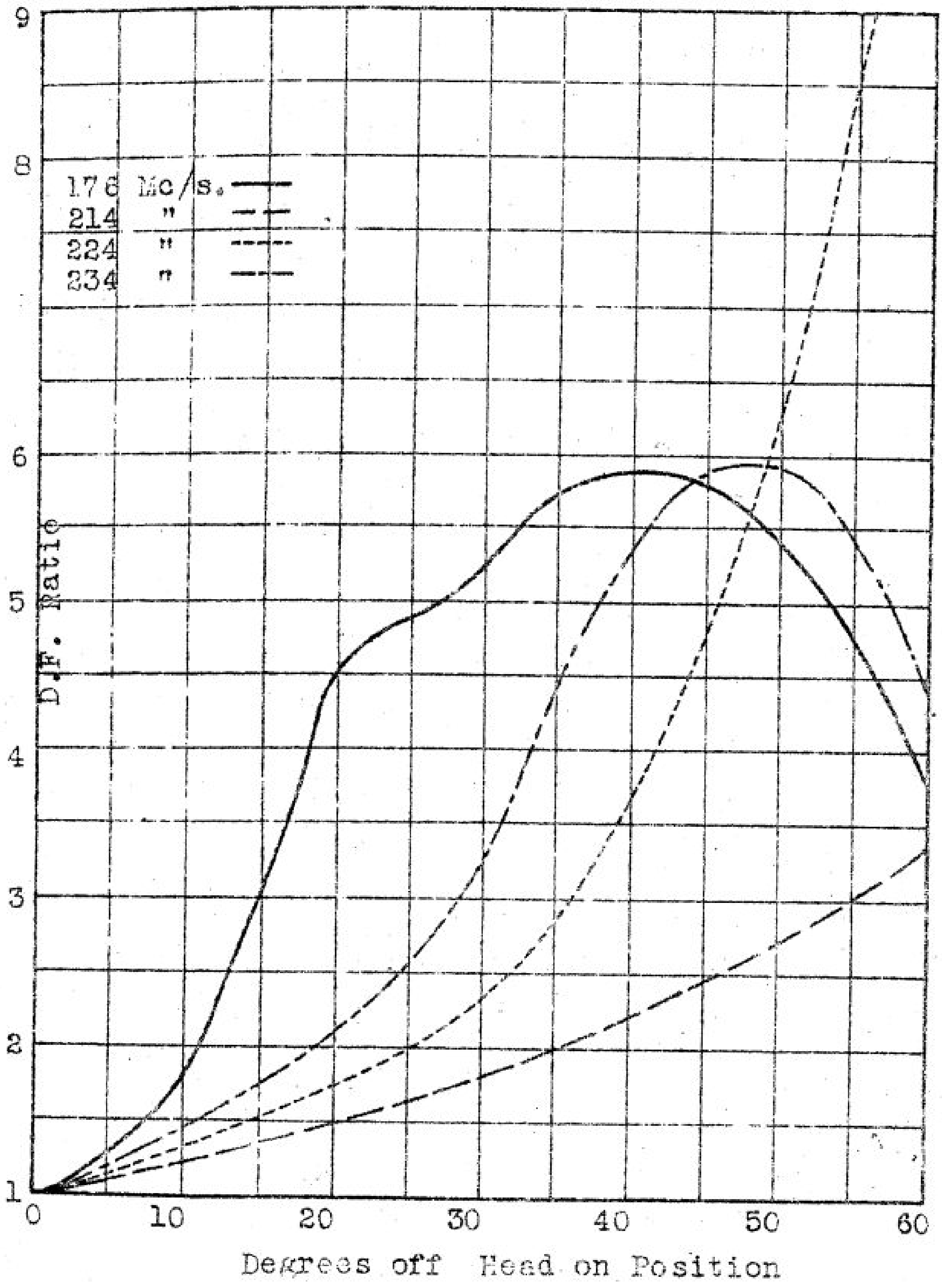


Fig. 7.

POLAR PATTERN FOR 4-ELEMENT ARRAY 45° TO LINE OF FLIGHT FREQUENCY = 176 Mc/s.

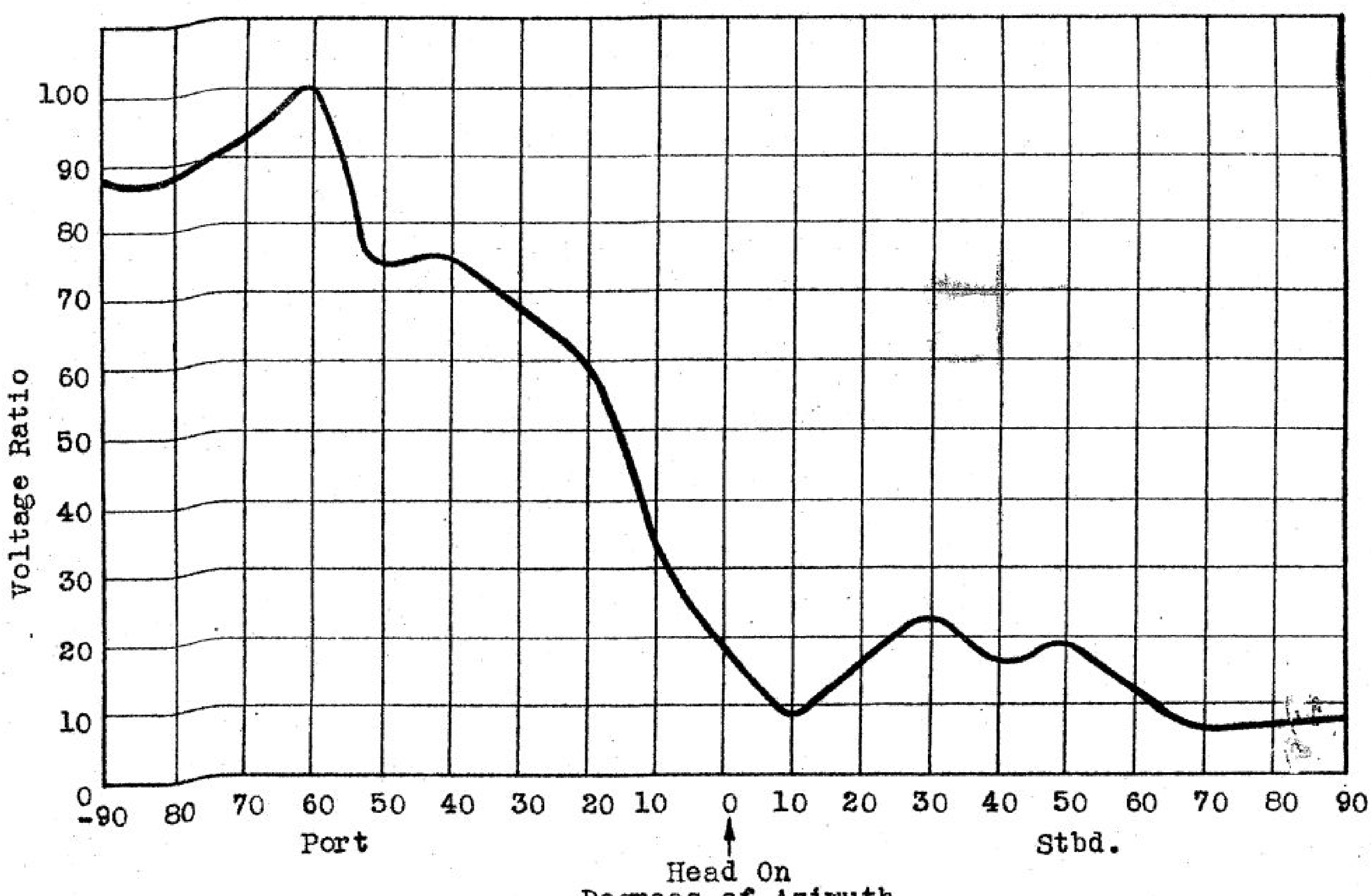


Fig. 8.

POLAR PATTERN FOR 4-ELEMENT ARRAY 45° TO LINE OF FLIGHT
FREQUENCY = 214 Mc/s

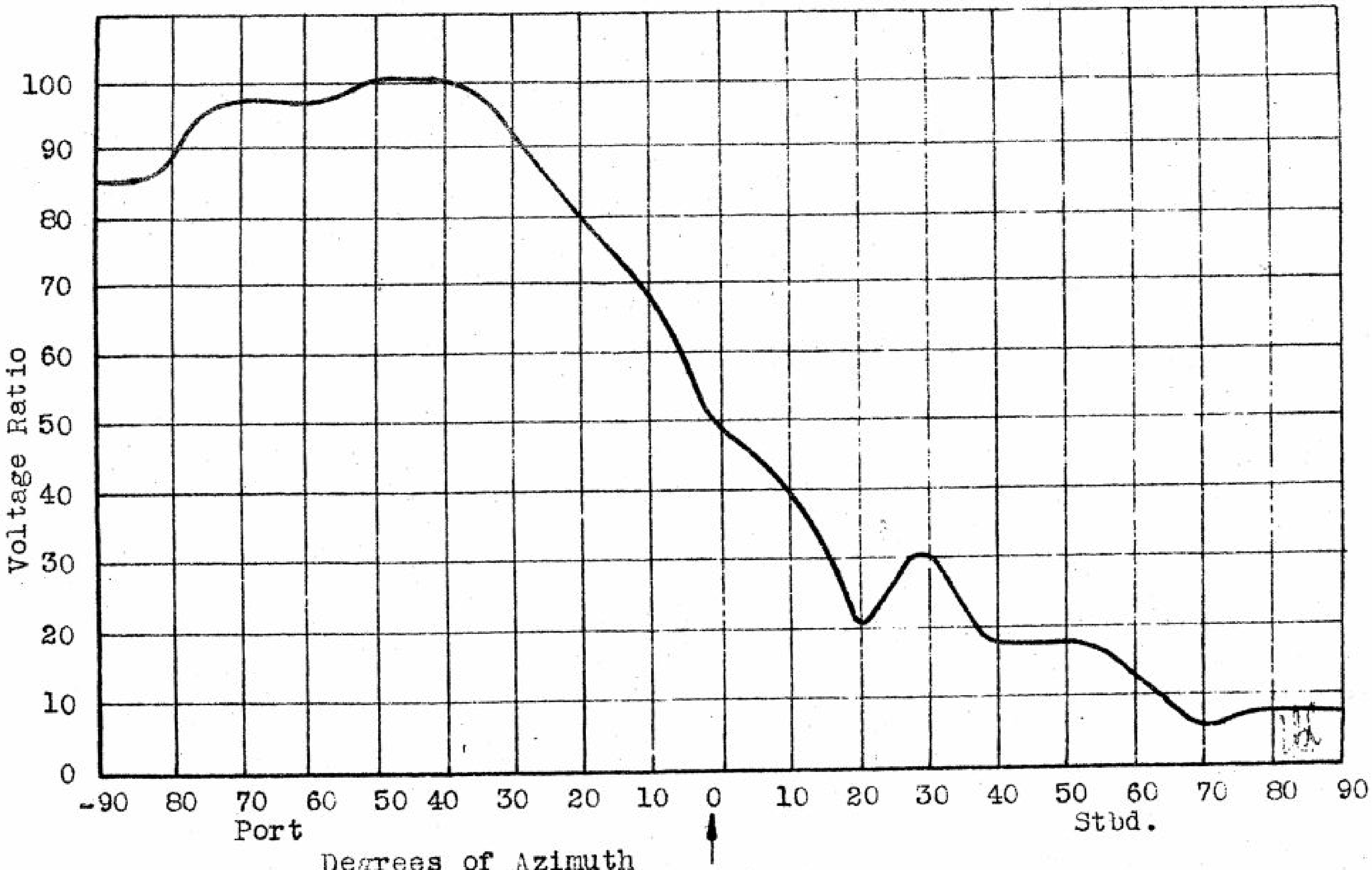


Fig. 9.

POLAR PATTERN FOR 4-ELEMENT ARRAY 45° TO
LINE OF FLIGHT

FREQUENCY = 224 Mc/s.

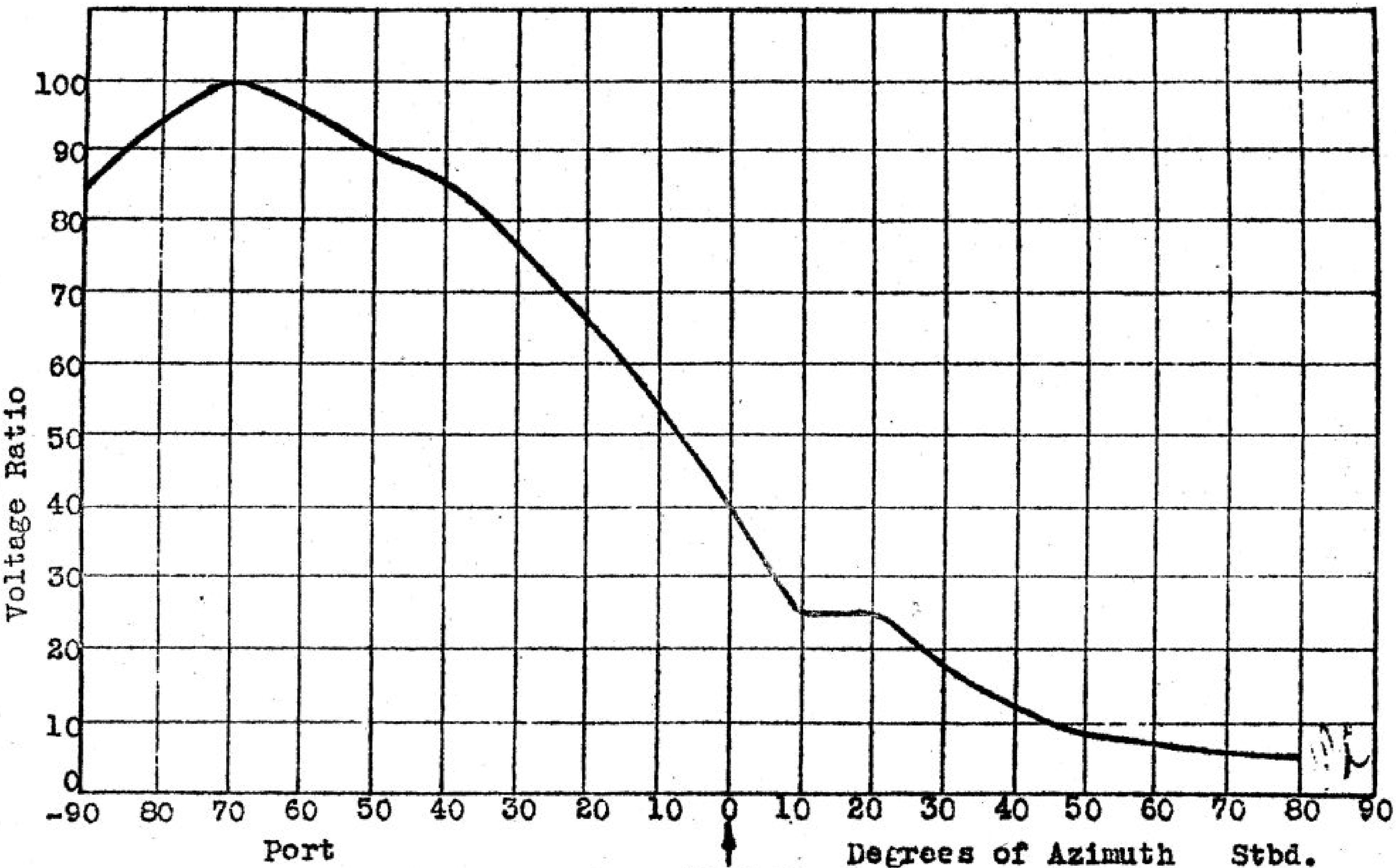


Fig. 10.

POLAR PATTERN FOR 4-ELEMENT ARRAY 45° TO LINE OF FLIGHT
FREQUENCY = 234 Mc/s.

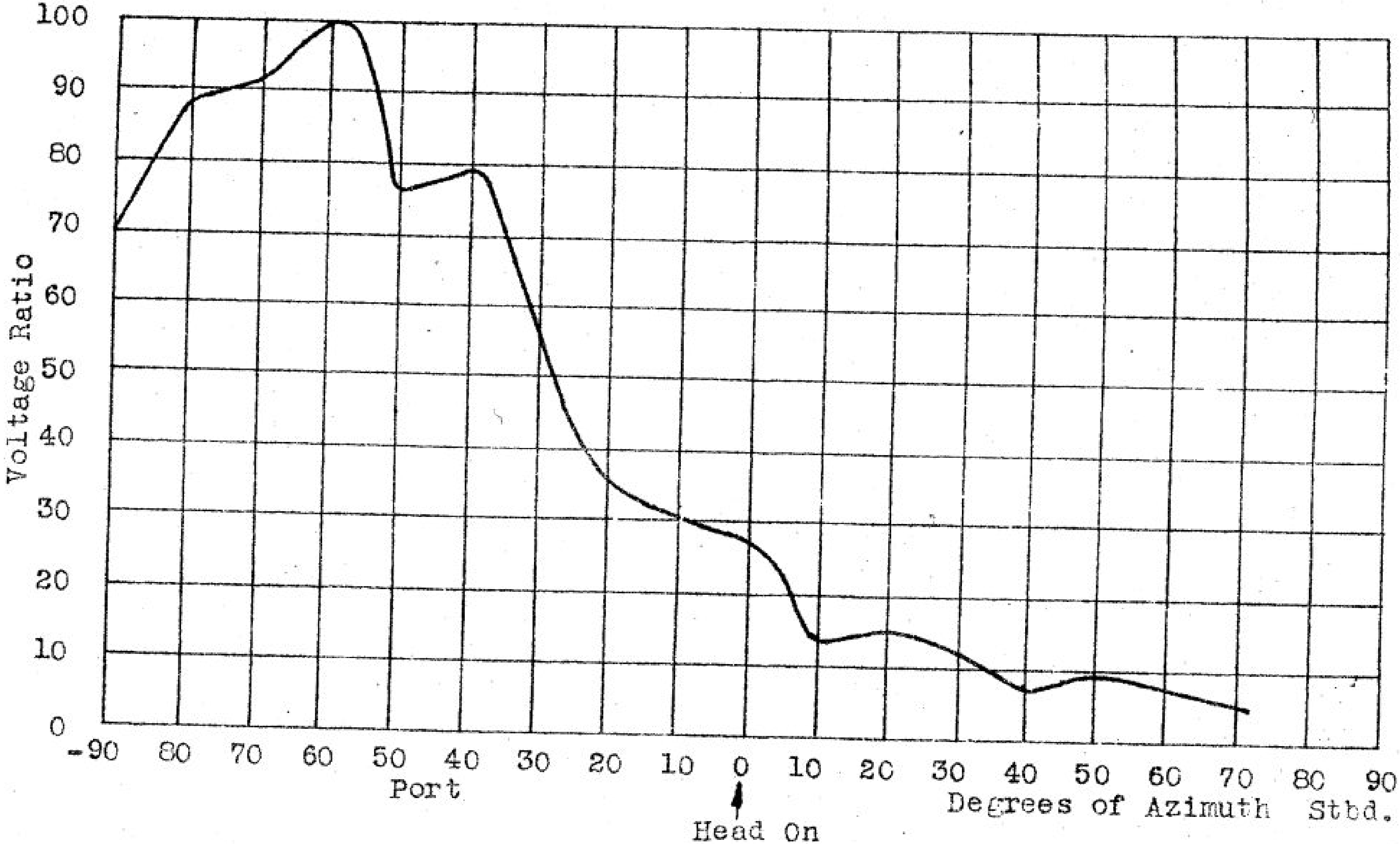
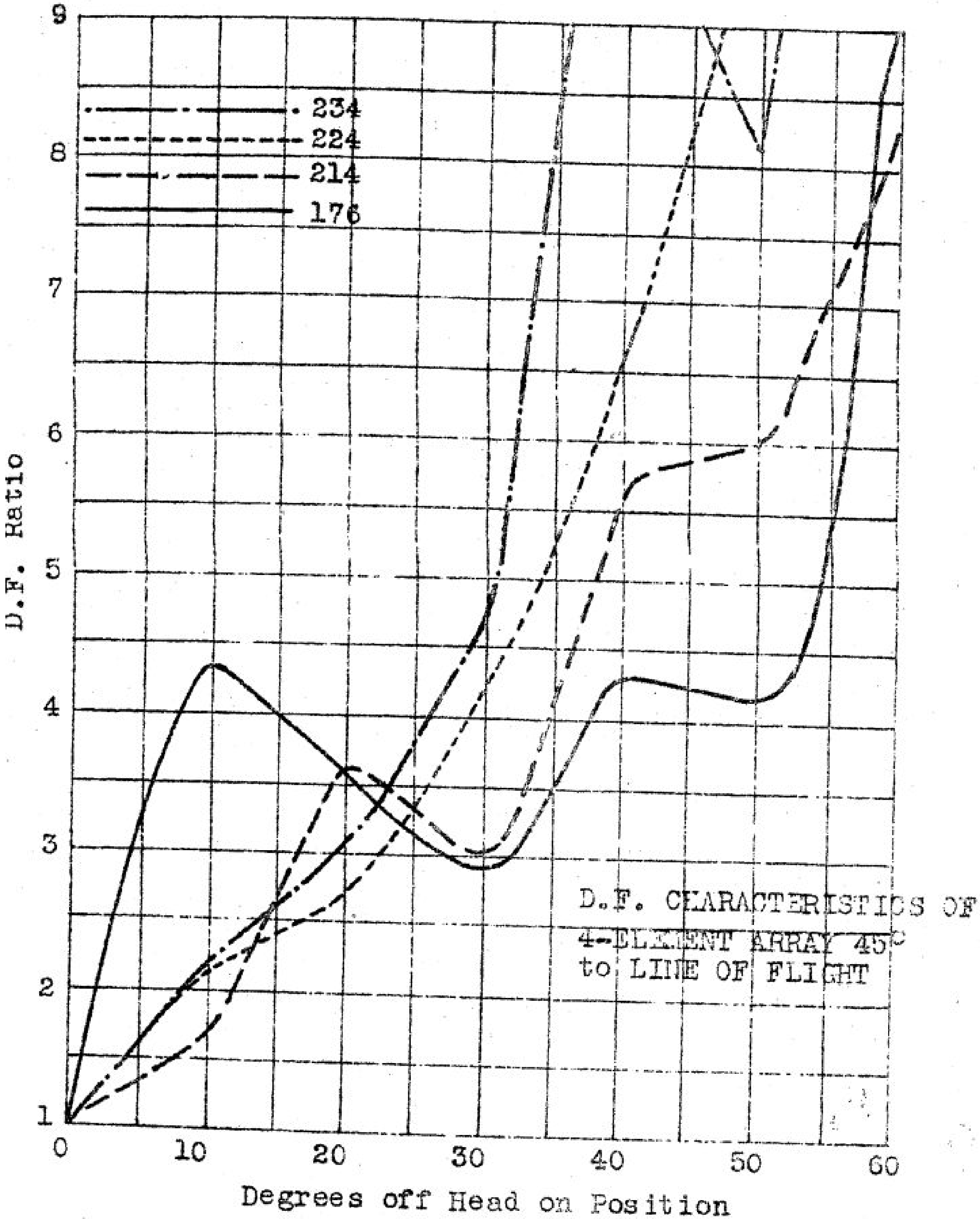


Fig. 11.



234
224
214
176
D.F. CHARACTERISTICS OF
4-ELEMENT ARRAY 45°
to LINE OF FLIGHT
D.F. Ratio
Degrees off Head on Position
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60

Fig. 12.

TYPICAL POLAR DIAGRAMS FOR REBECCA AERIALS ON
PORT WING OF BEAUFIGHTER

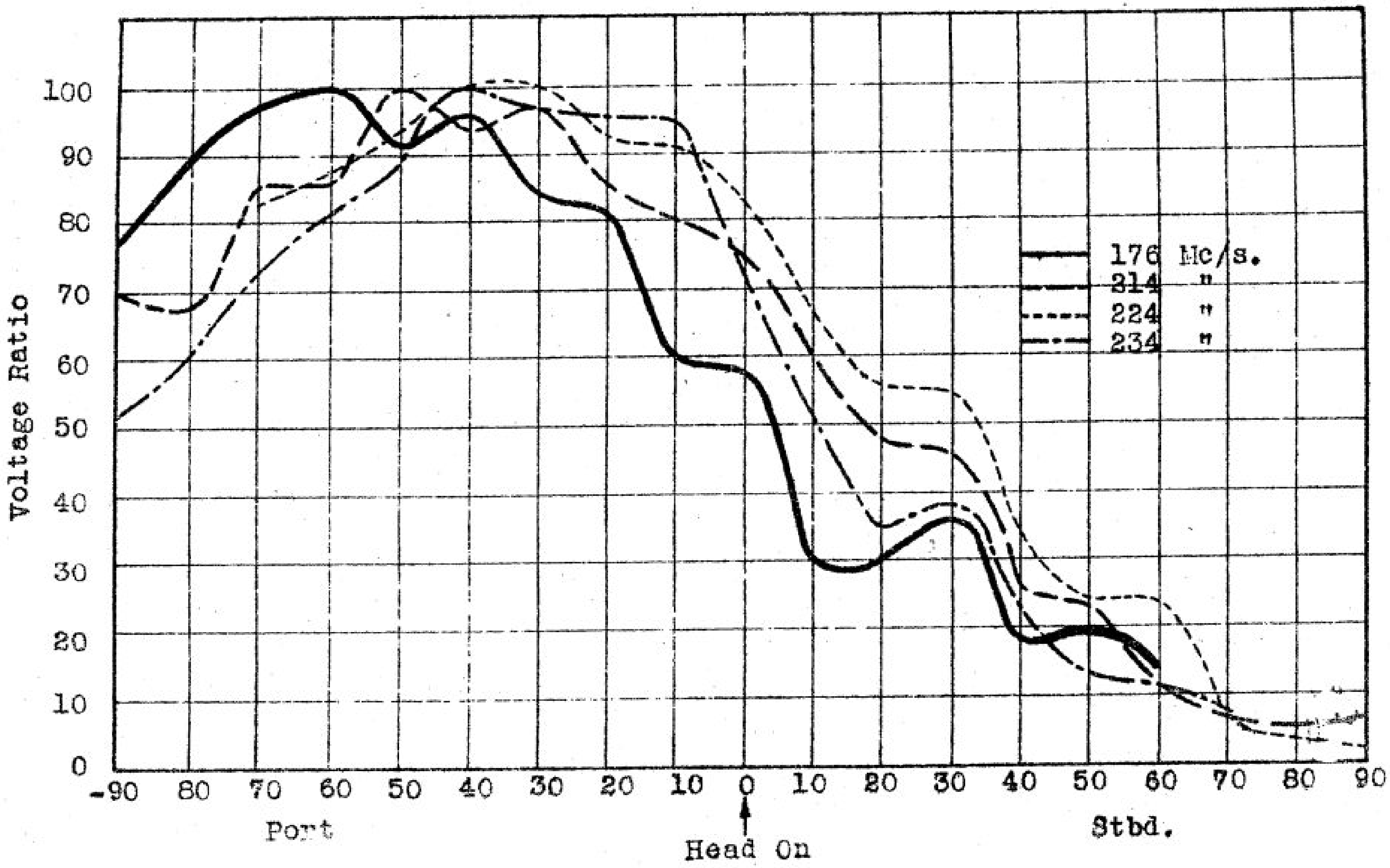


Fig. 13.

D.F. CHARACTERISTICS OF REBECCA
WING AERIAL (taken on ground)

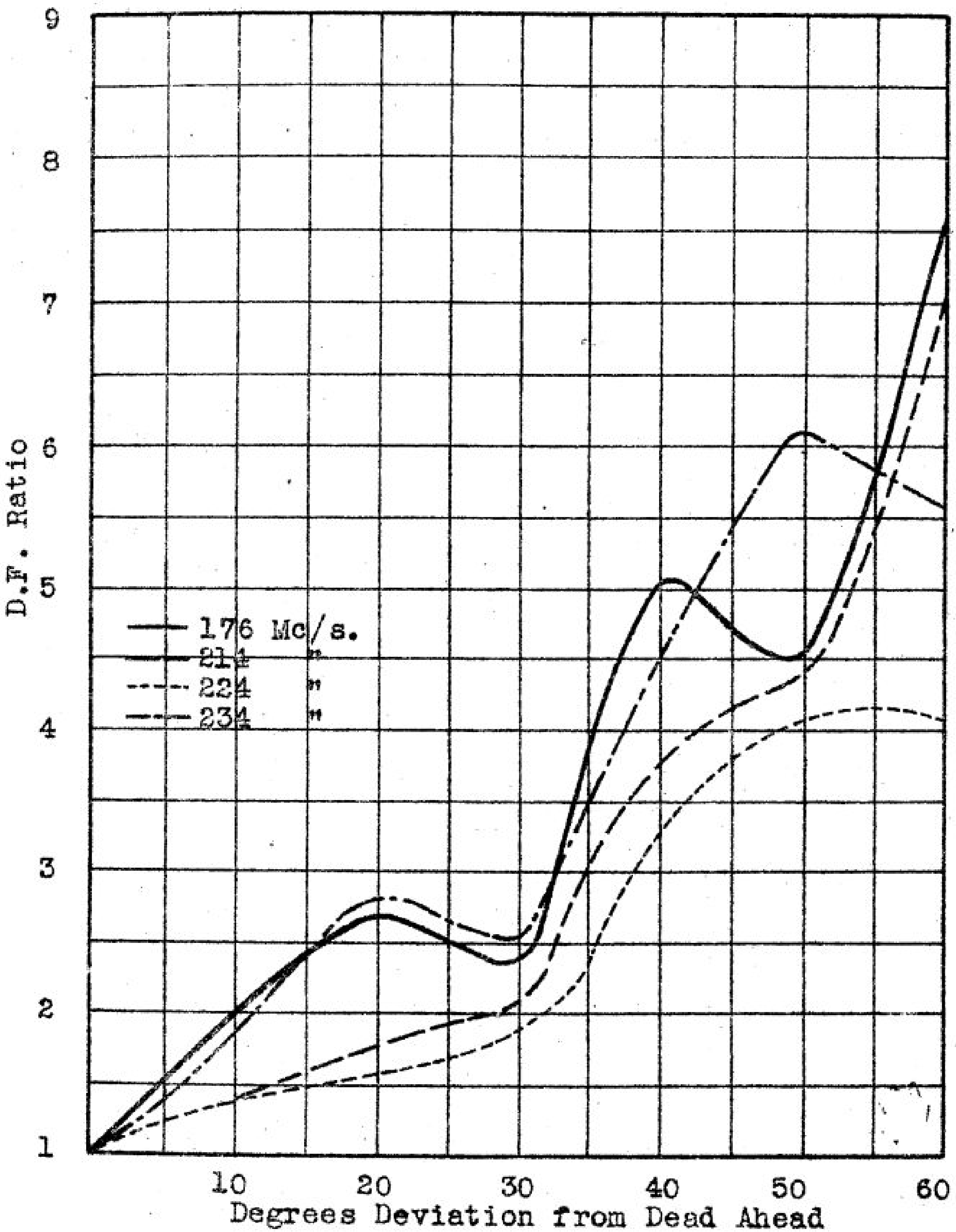


Fig. 14

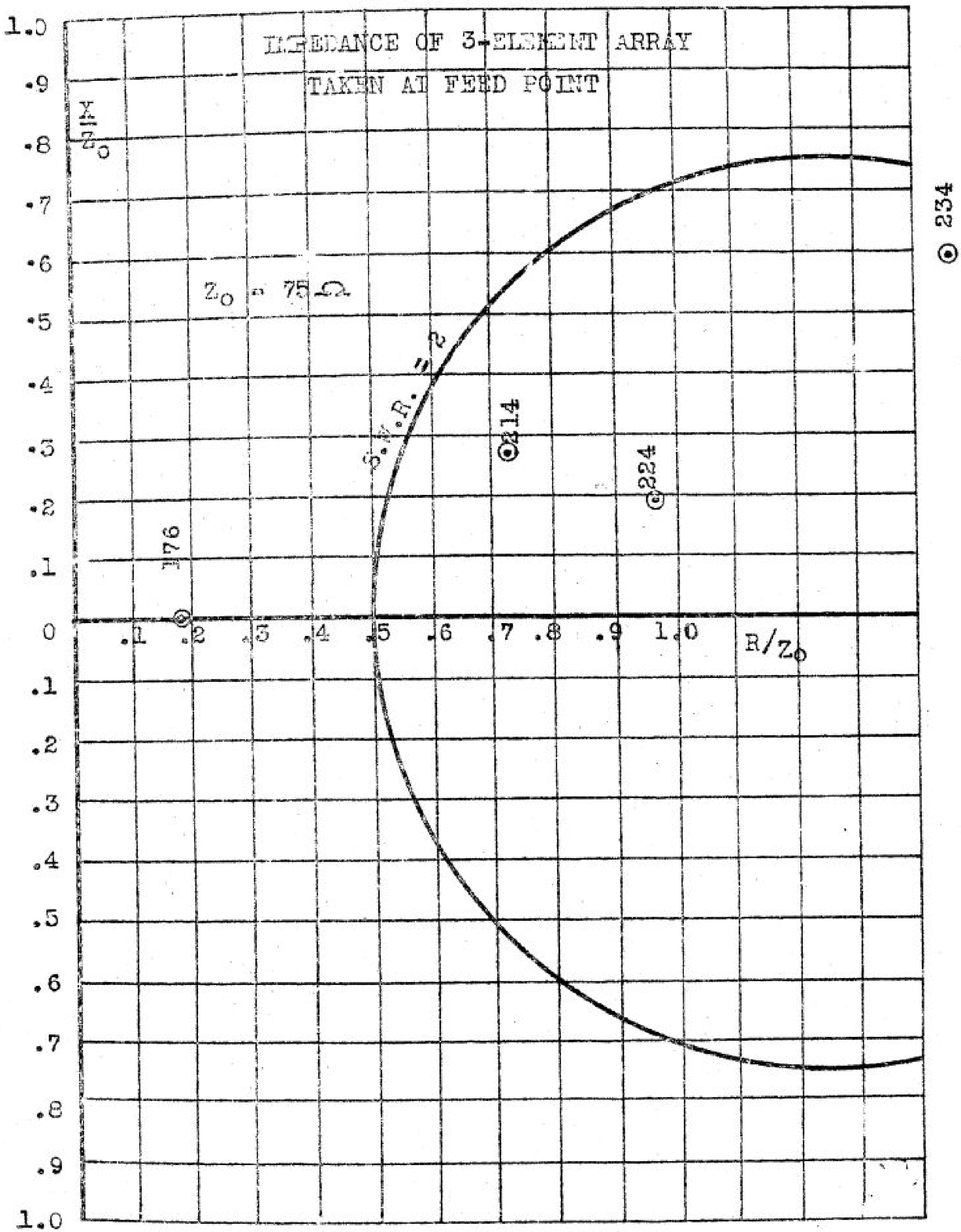

IMPEDANCE OF 3-ELEMENT ARRAY
TAKEN AT FEED POINT
X/Zo
Zo = 75 Ω
S.W.R. = 2
176
214
224
234
R/Zo
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Fig. 15.

IMPEDANCE OF 3-ELEMENT ARRAY AT JUNCTION OF TRANSFORMER

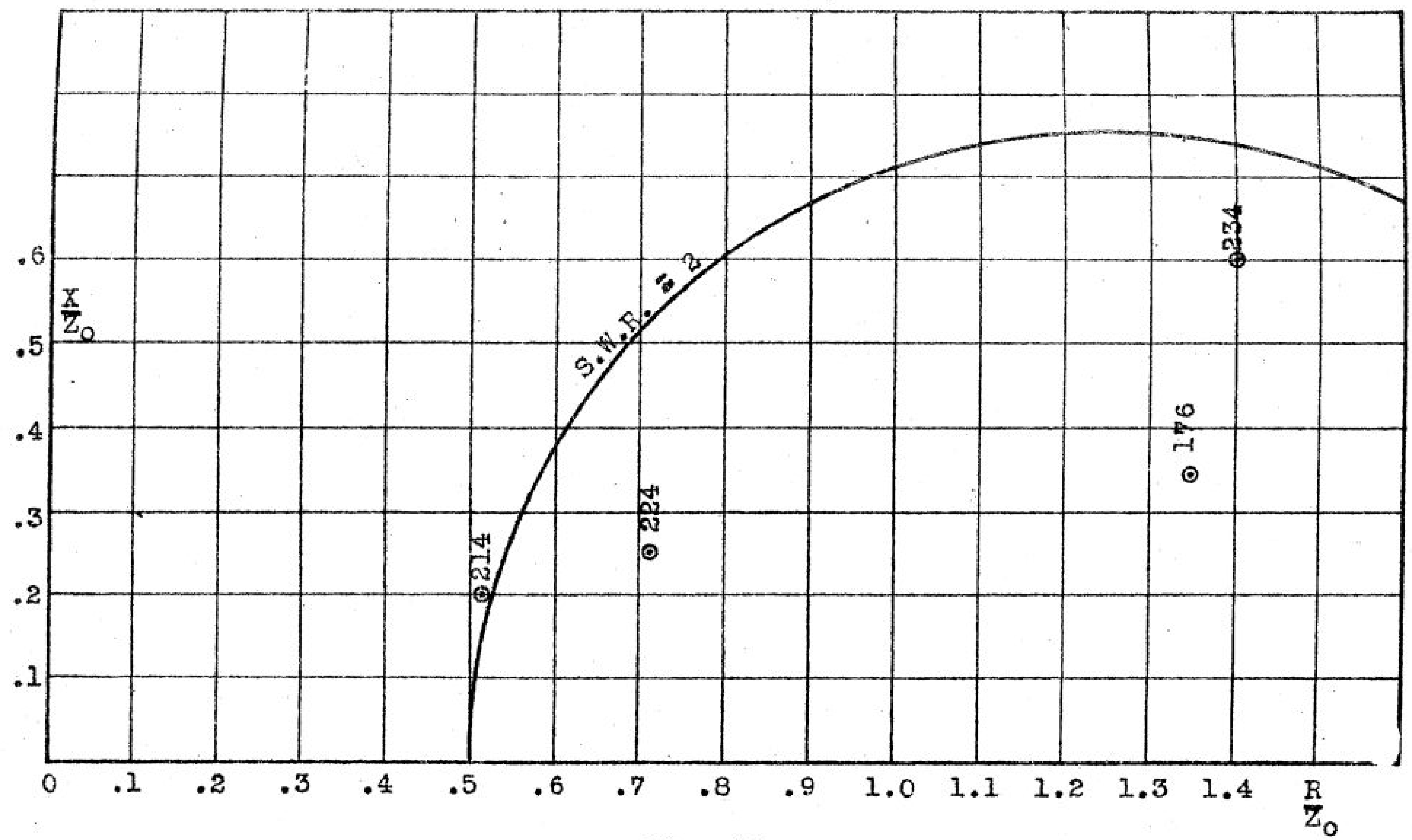


Fig. 16.

MISMATCH OF 4-ELEMENT ARRAY
WITH TWO 35" LENGTHS OF UNIRADIO No.1
IN PARALLEL

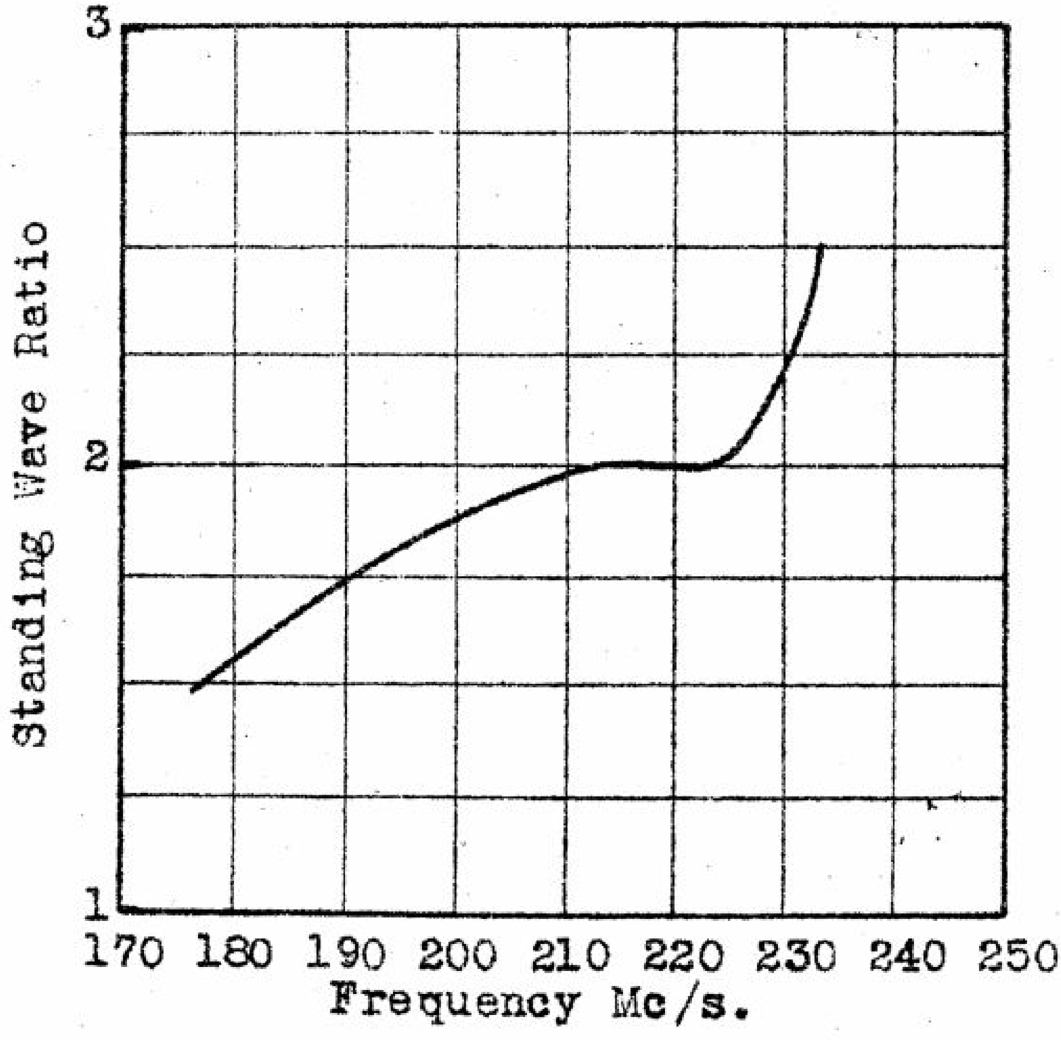


Fig. 17.

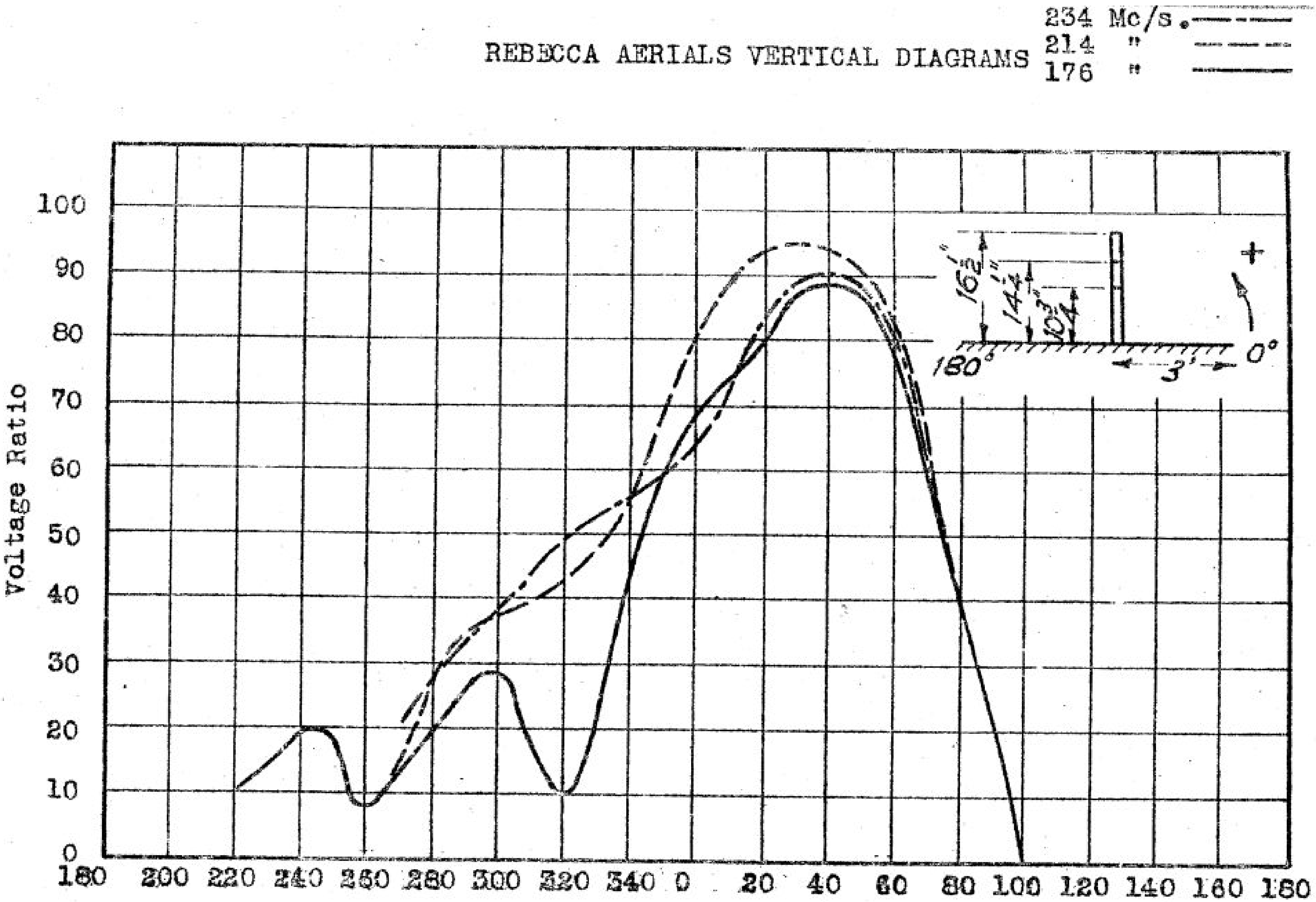

REBECCA AERIALS VERTICAL DIAGRAMS
234 Mc/s.
214 "
176 "
Voltage Ratio
100
90
80
70
60
50
40
30
20
10
0
180 200 220 240 260 280 300 320 340 0 20 40 60 80 100 120 140 160 180
180°
0°
3'
+

Fig. 18.

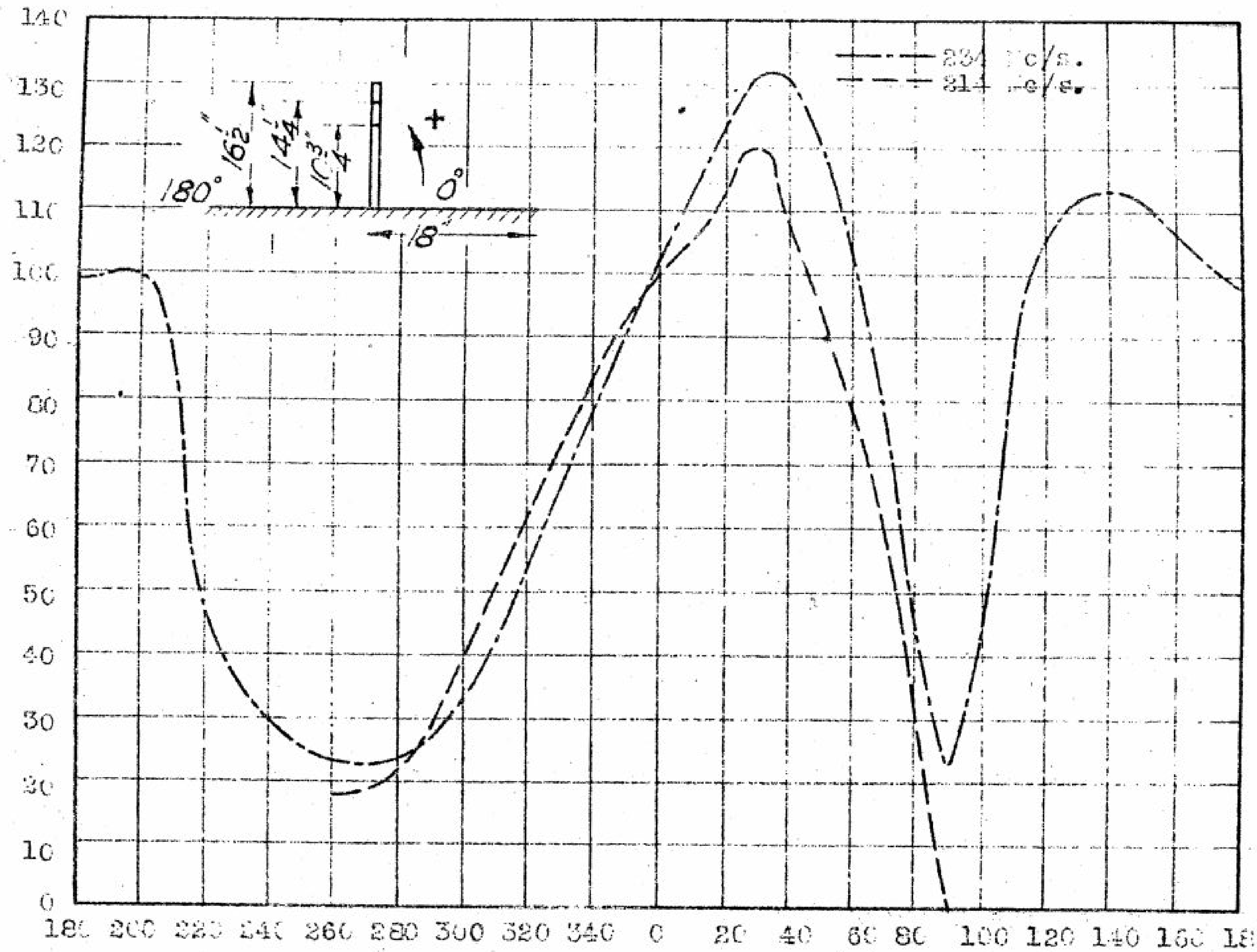
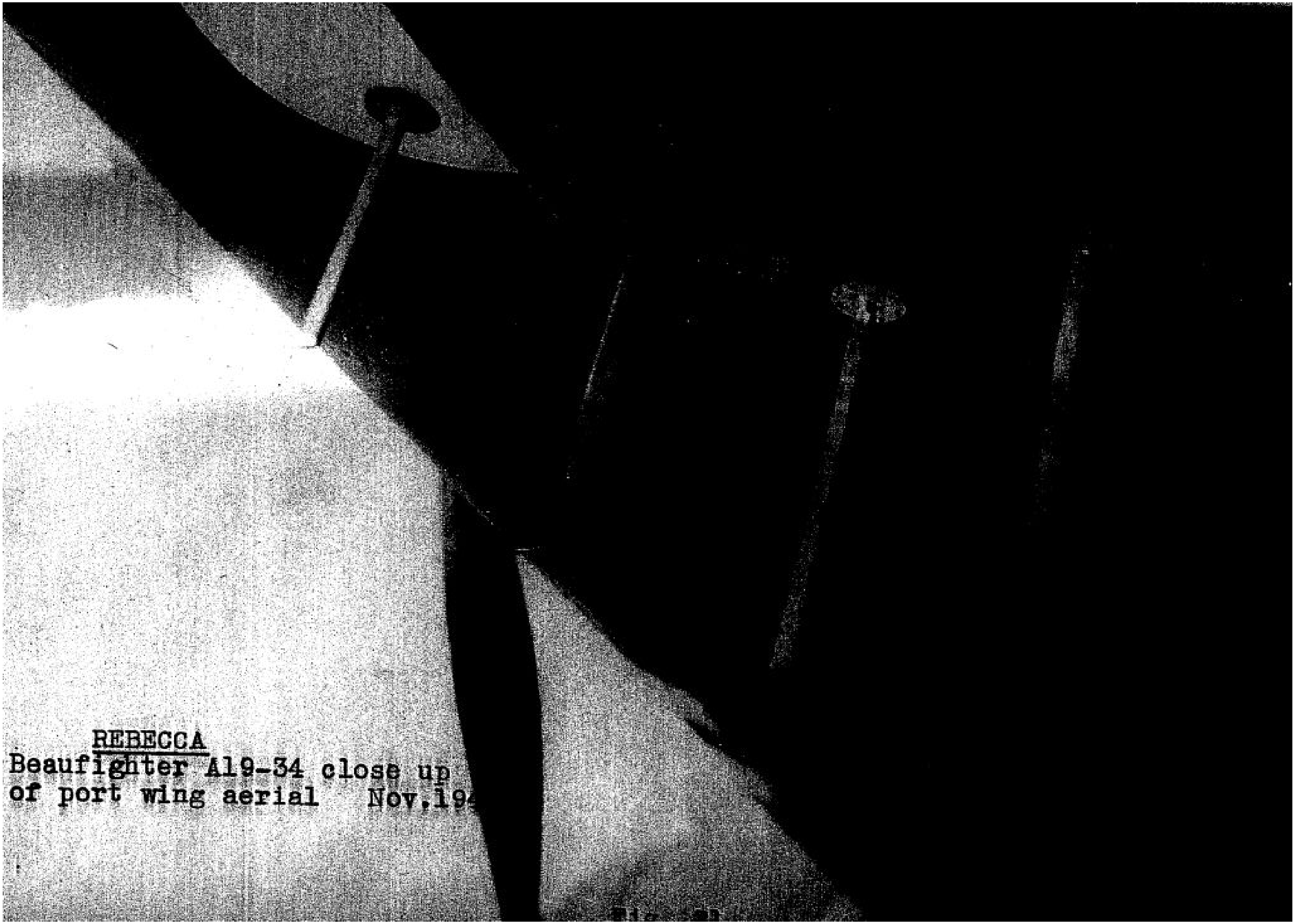
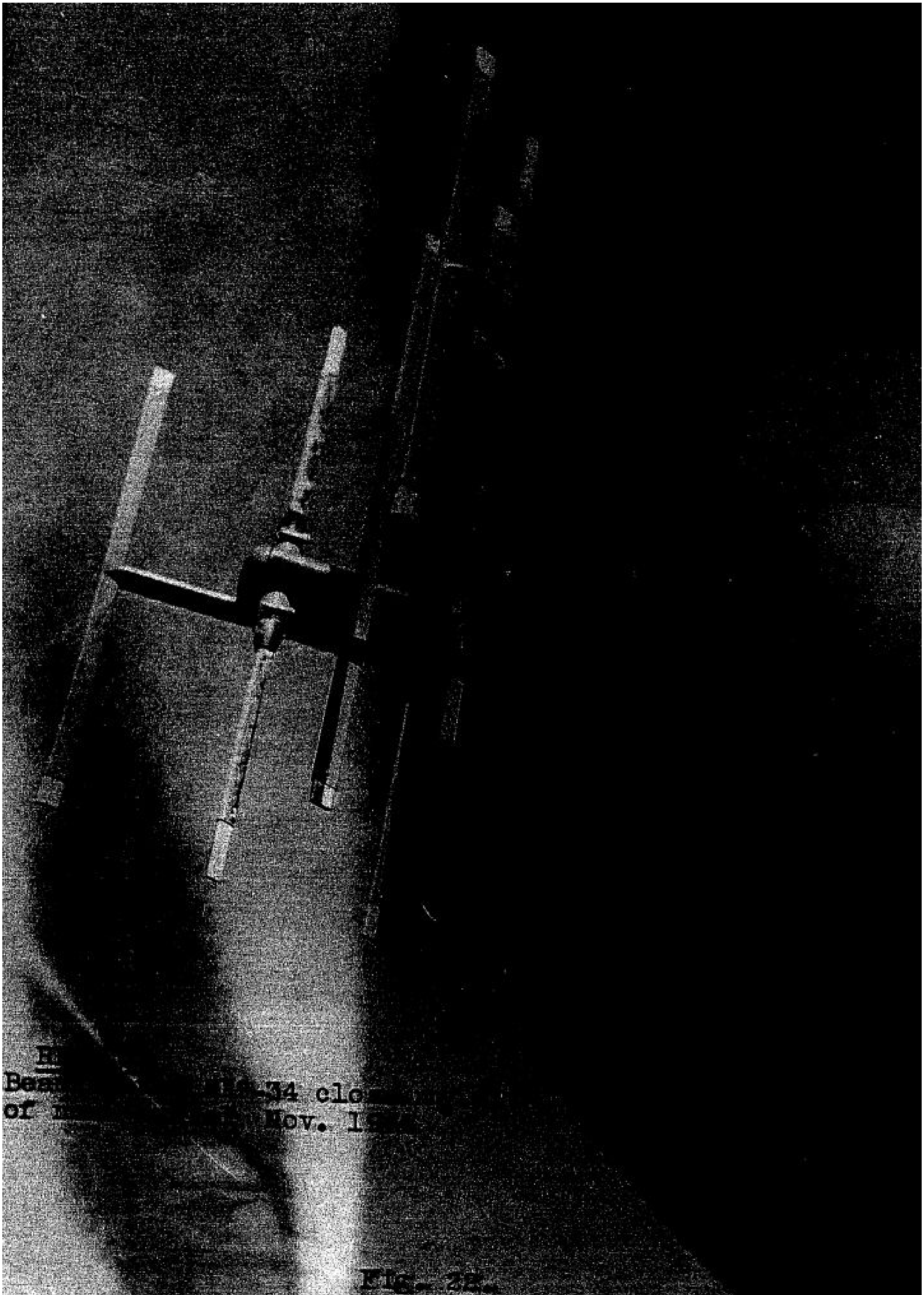


Fig. 19.


REBECCA
Beaufighter A19-34 close up
of port wing aerial Nov.194



H[illegible]
Bea[illegible]-34 clo[illegible]
of [illegible] Nov. 1[illegible]

Fig. 22.

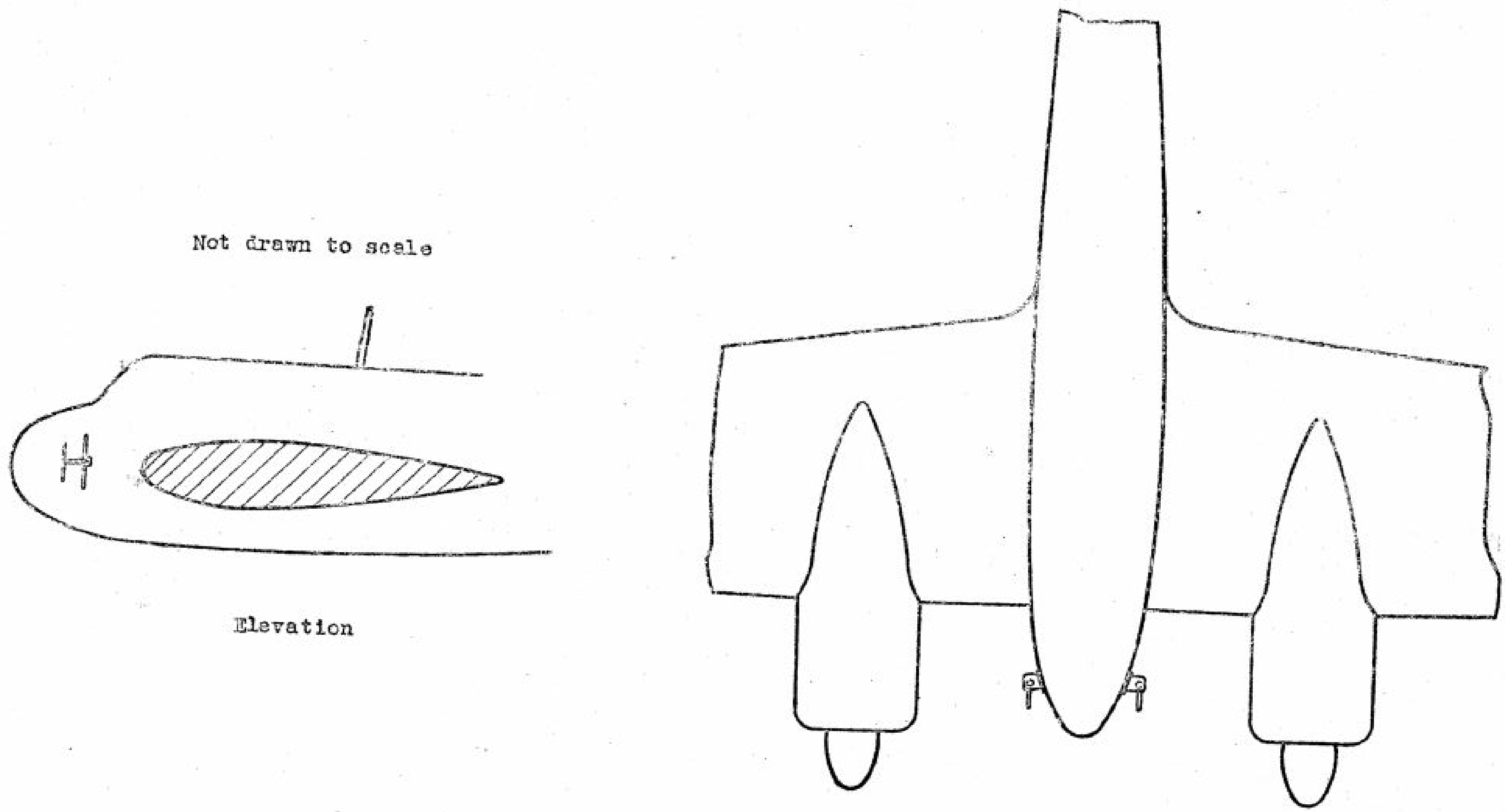
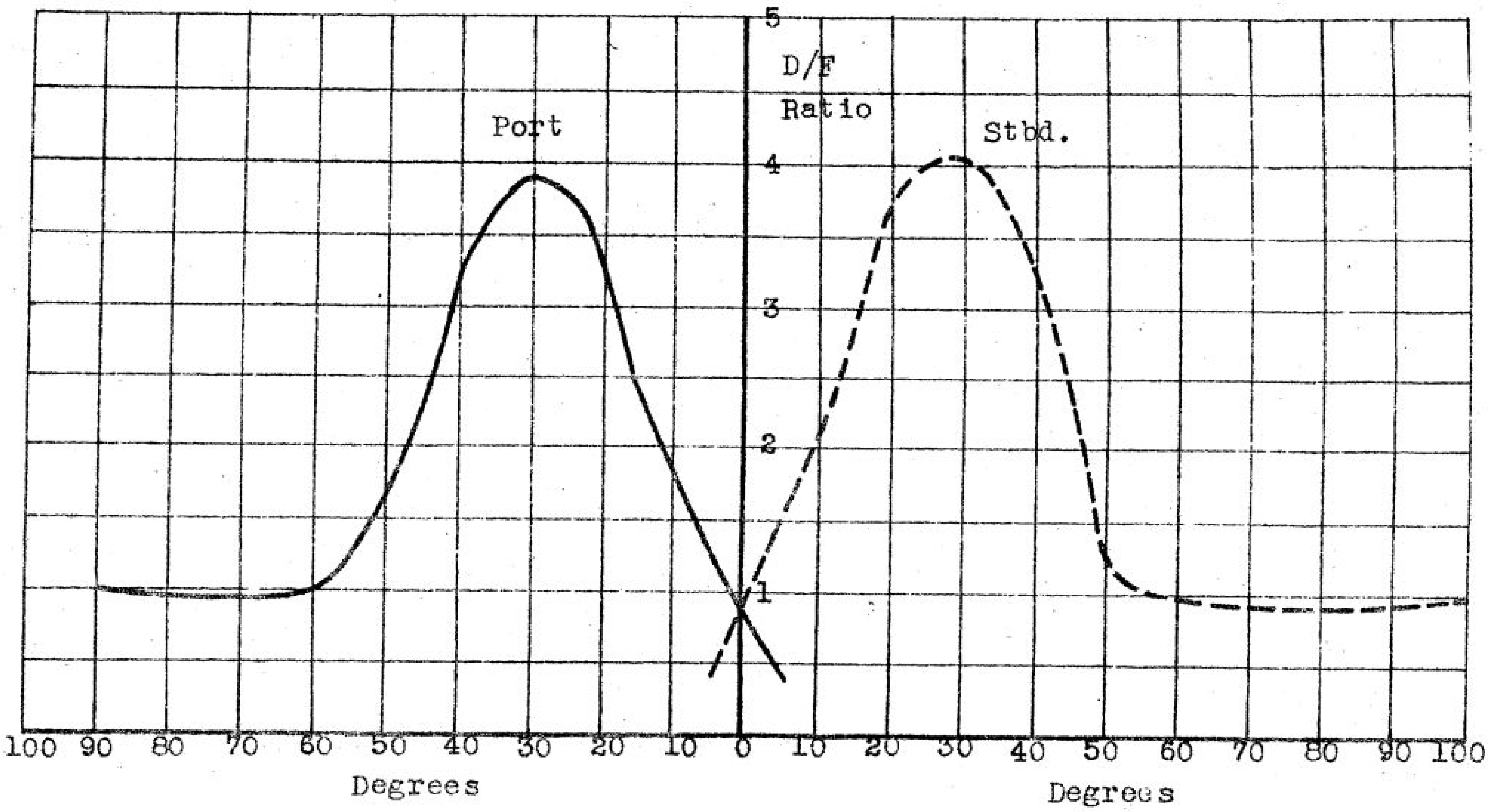
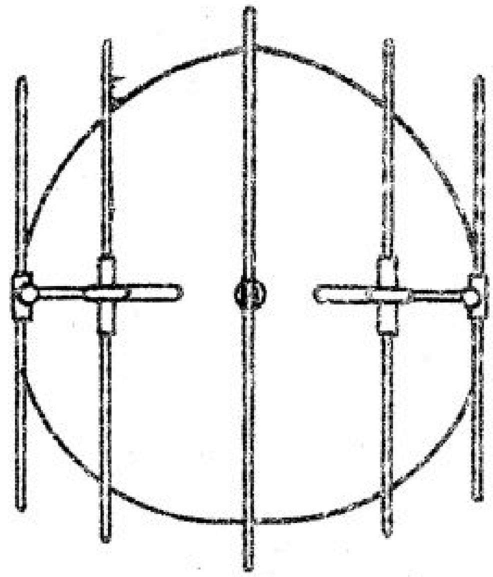


Fig. 23.



BRITISH Mk II AERIALS ON BEAUFIGHTER A19-34
D/F RATIOS AT 224 Mc/s. TAKEN IN FLIGHT

Fig. 24.



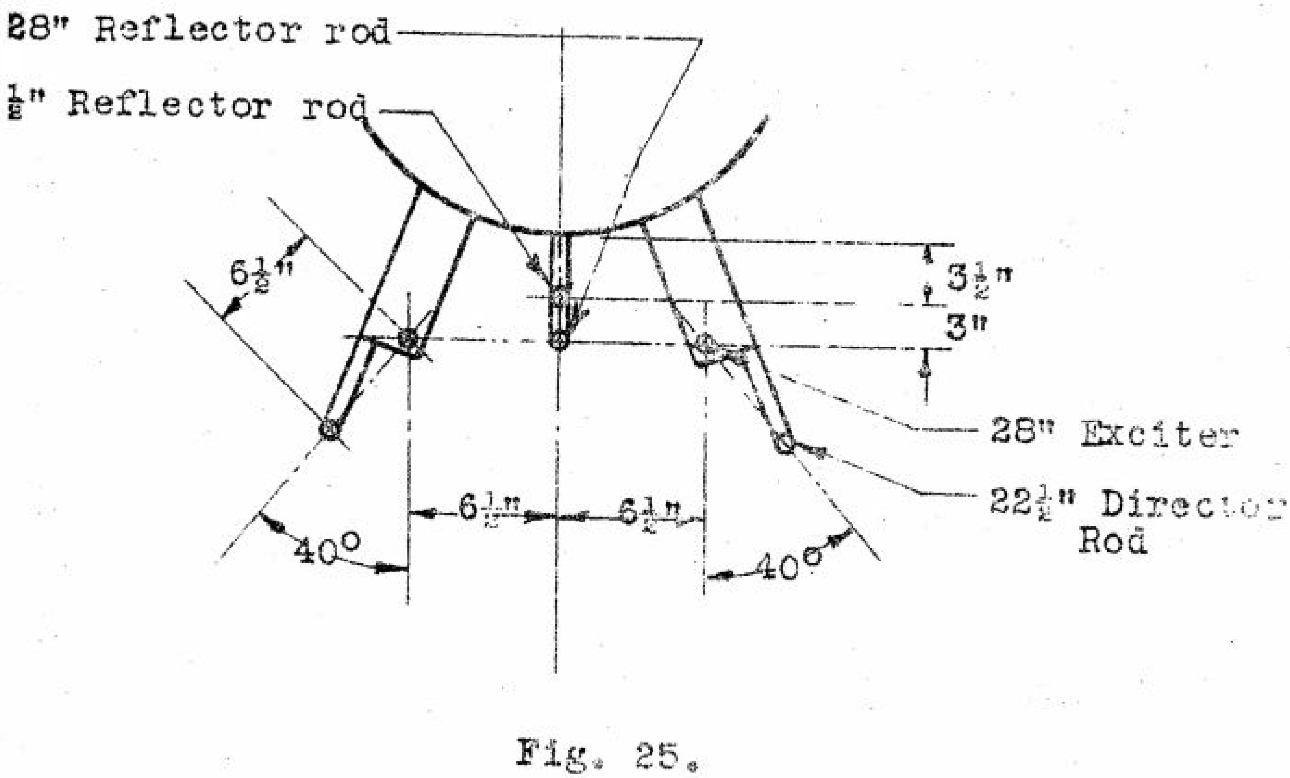

28" Reflector rod
½" Reflector rod
6½"
3½"
3"
28" Exciter
22½" Director Rod
6½"
6½"
40°
40°

Fig. 25.

REBECCA NOSE AERIALS ON BEAUFIGHTER A19-34

POLAR DIAGRAMS

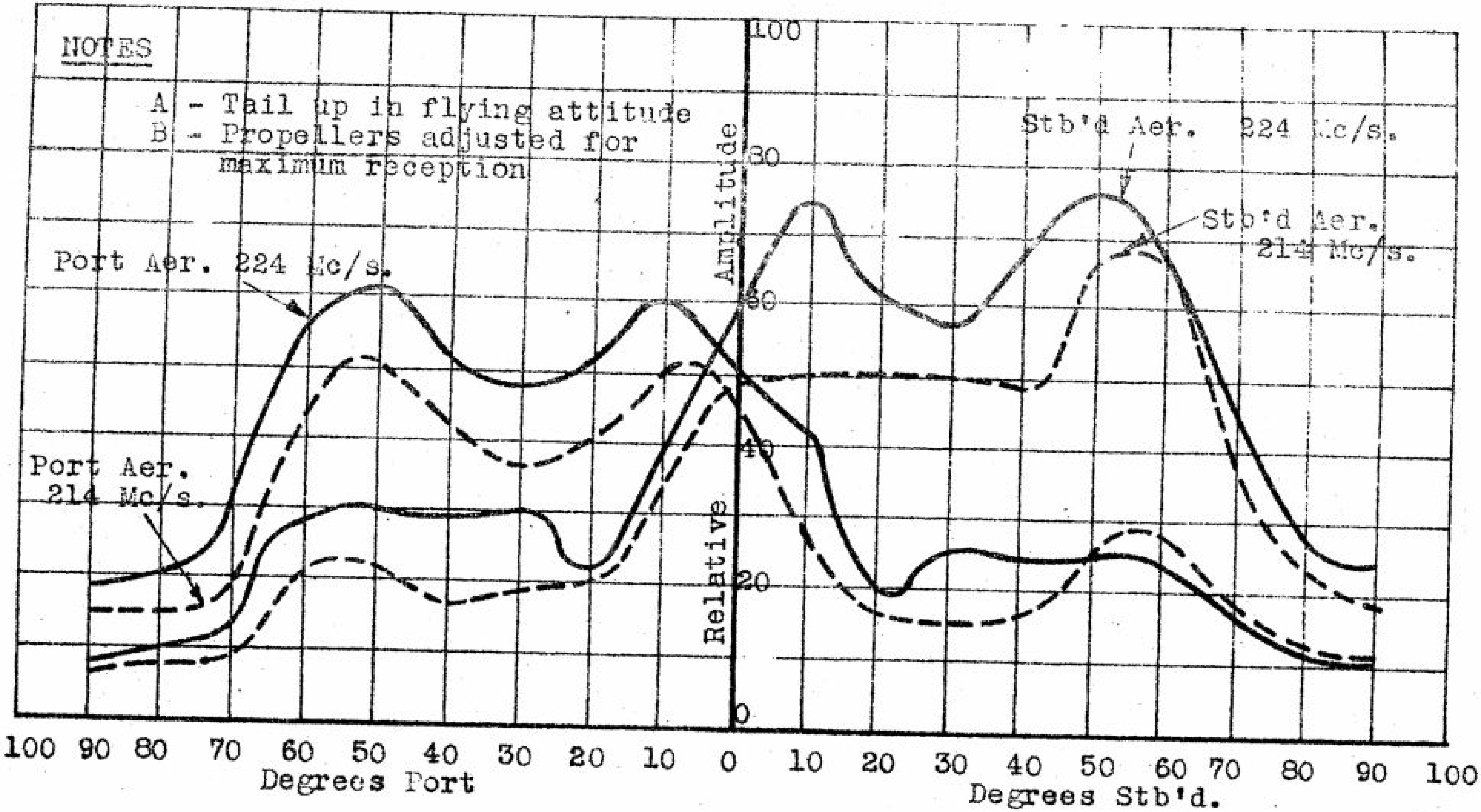


Fig. 26.

REBECCA NOSE AERIALS ON BEAUFIGHTER A19-34 - POLAR DIAGRAMS.

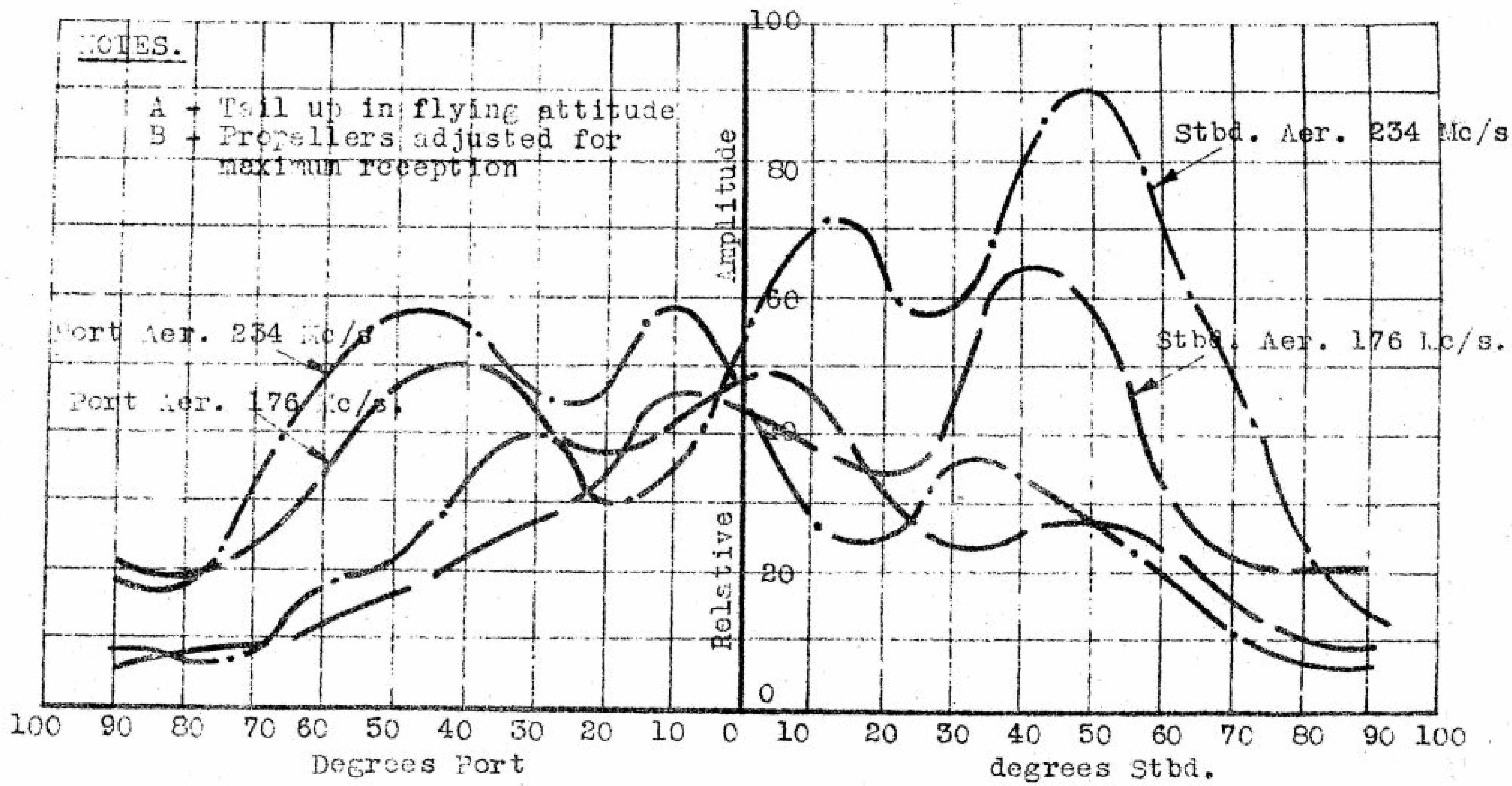


Fig. 27.

REBECCA NOSE AERIALS ON BEAUFIGHTER A19-34 D/F DIAGRAMS

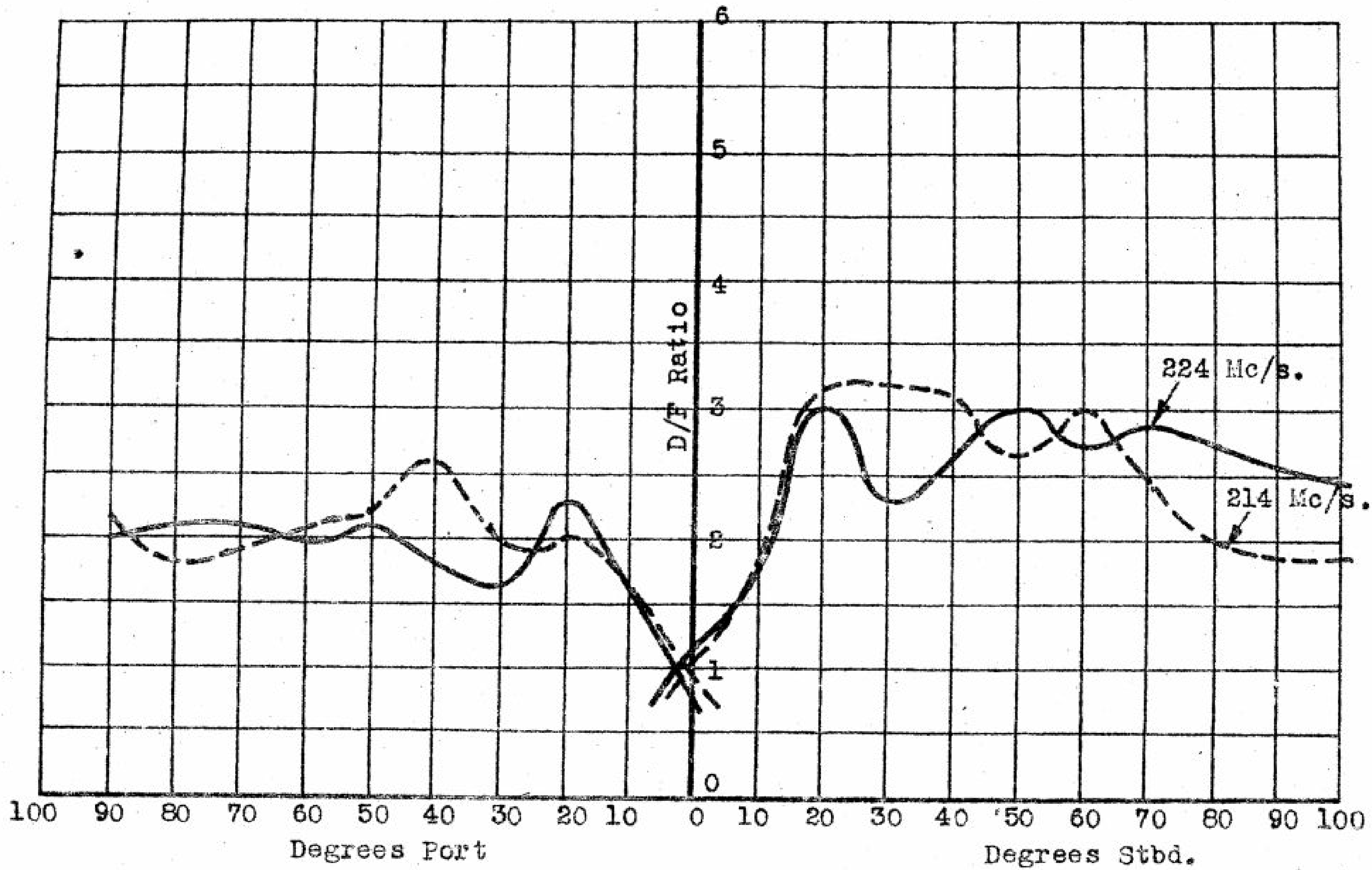


Fig. 28.

REBECCA NOSE AERIALS ON BEAUFIGHTER A19-34

D/F DIAGRAMS

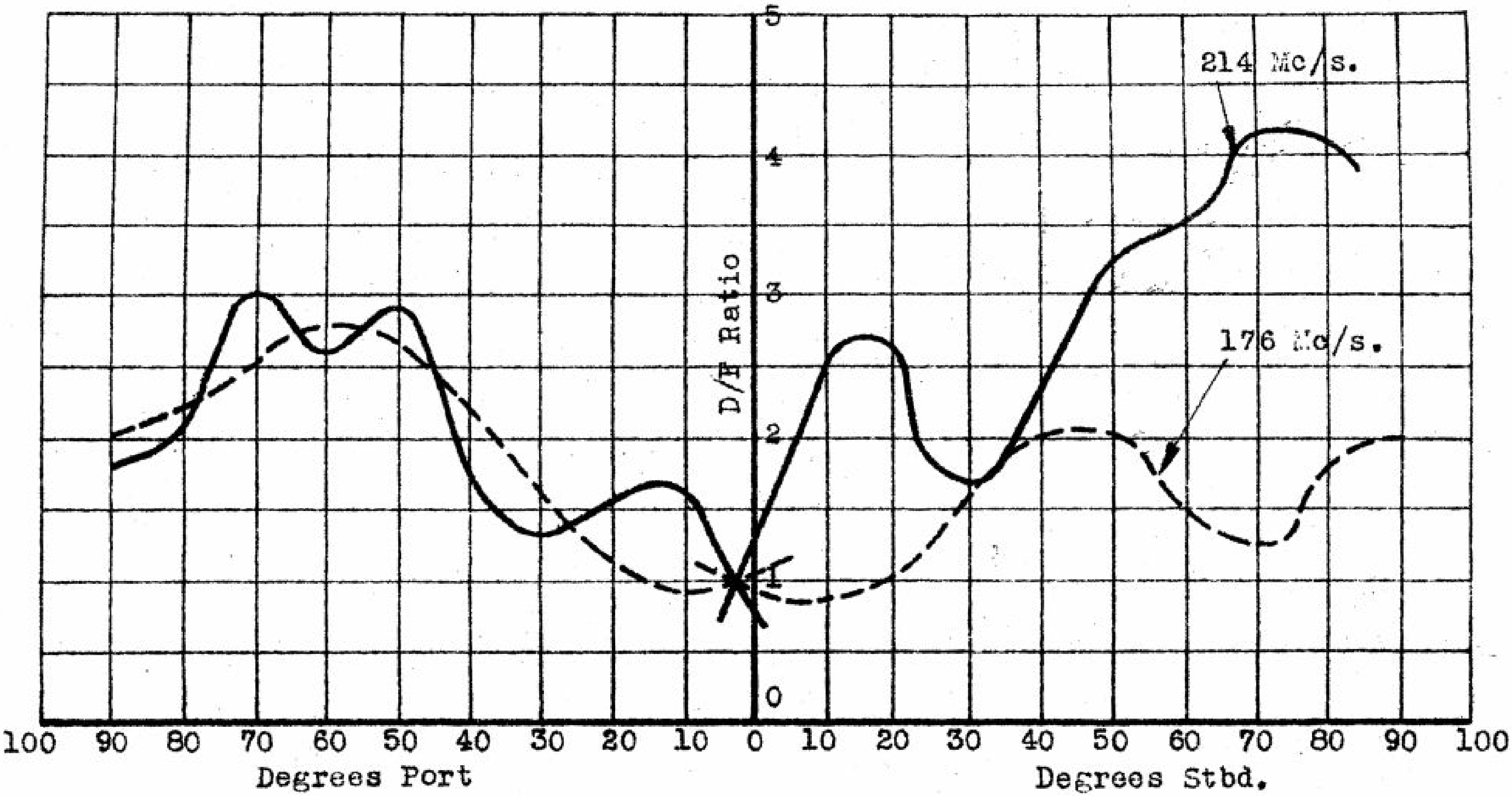


Fig. 29.

TAKEN IN FLIGHT

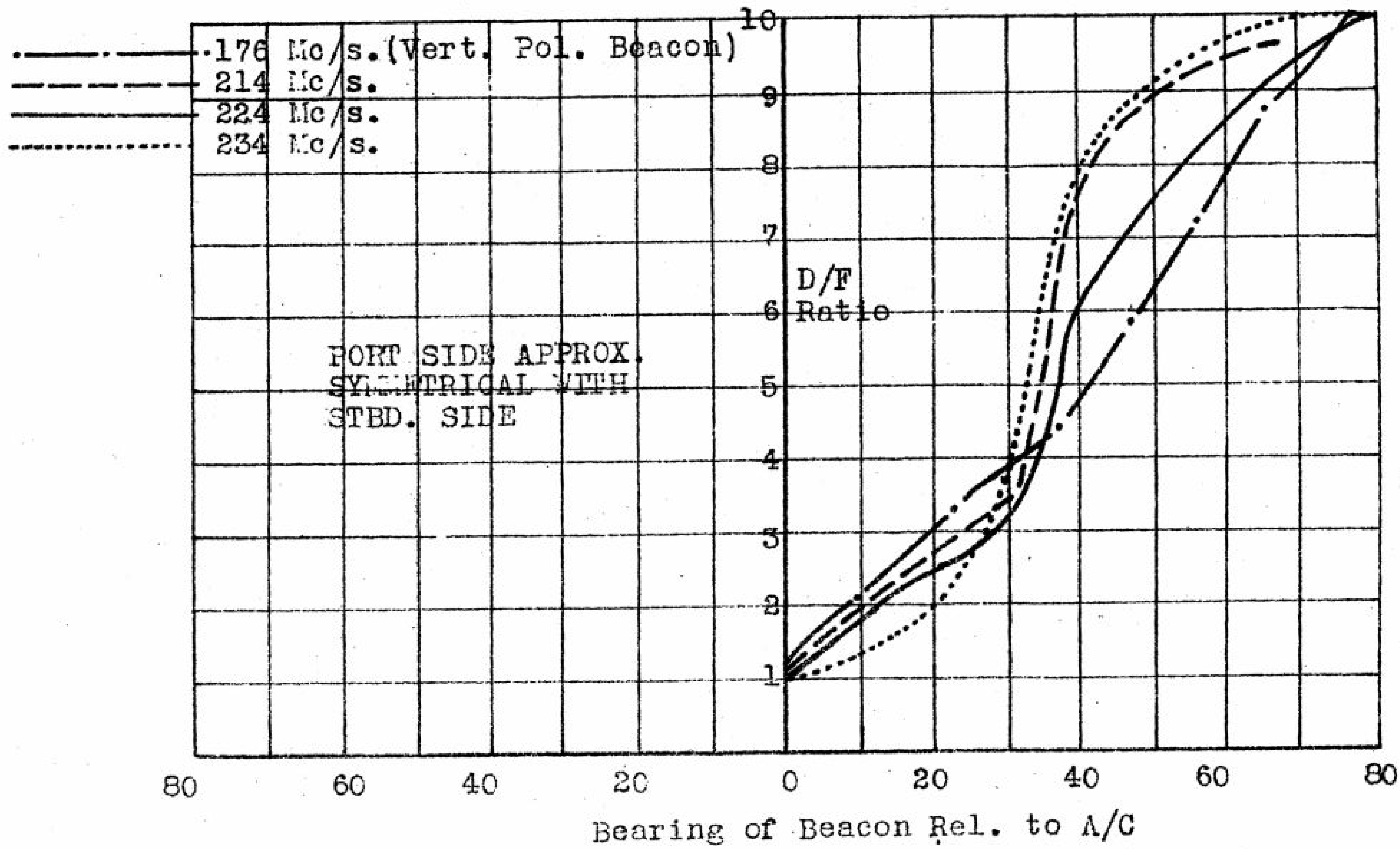


Fig. 30.

D/F RATIOS OF NOSE AERIALS FITTED TO

BEAUFIGHTER A19-34 TAKEN IN FLIGHT

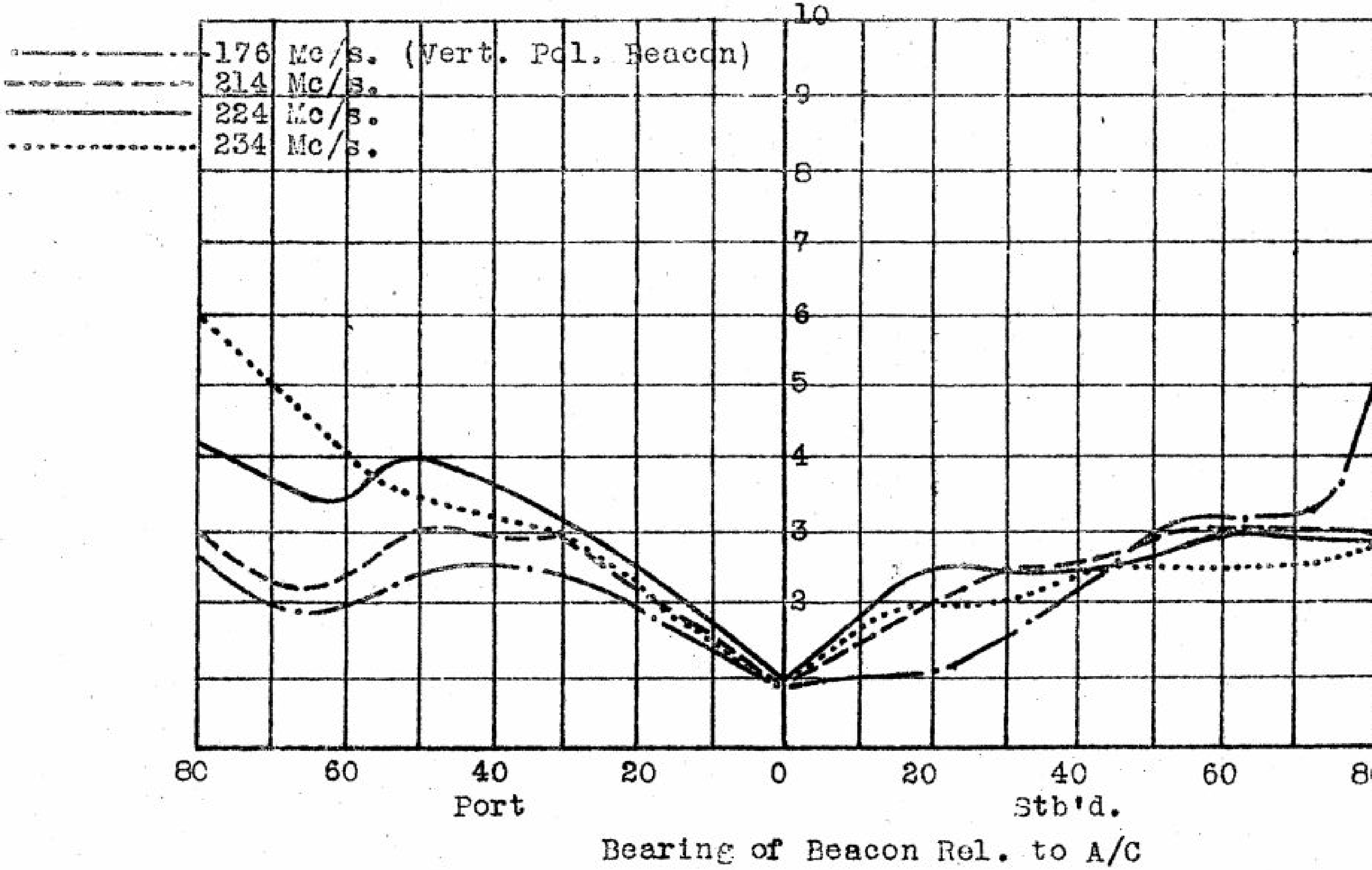
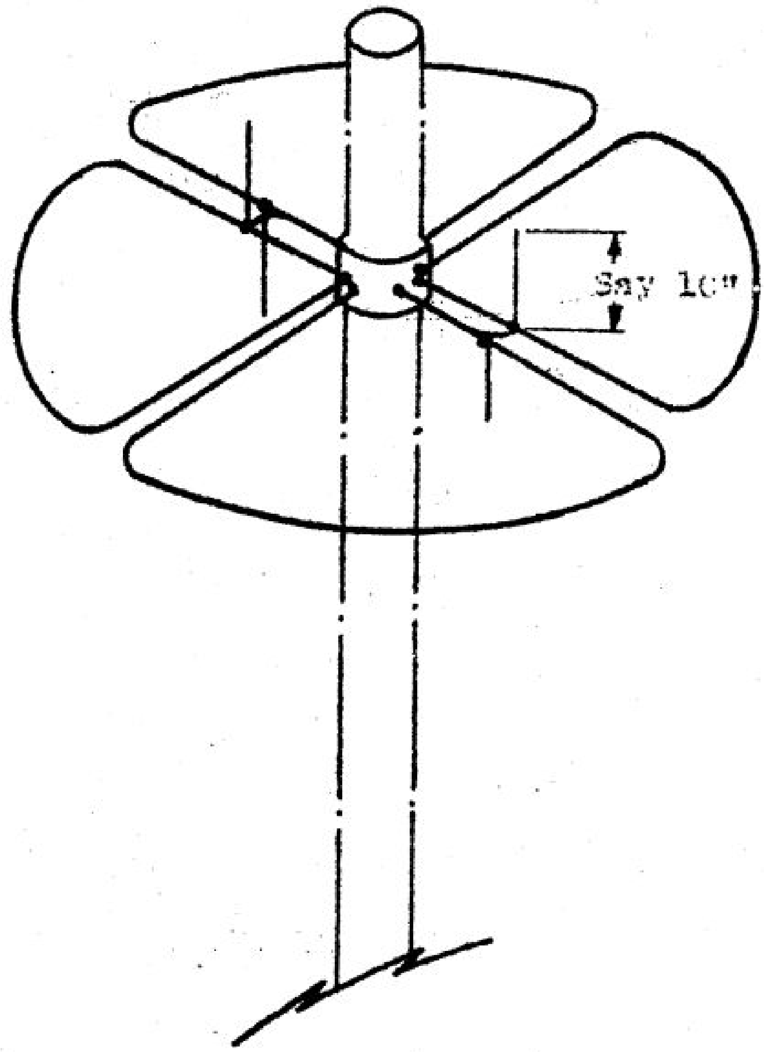


Fig. 31.



ADDITION TO A.S.V. BEACON AERIAL FOR PRODUCTION OF SMALL PROPORTION OF VERTICALLY POLARISED RADIATION.

Fig. 32.

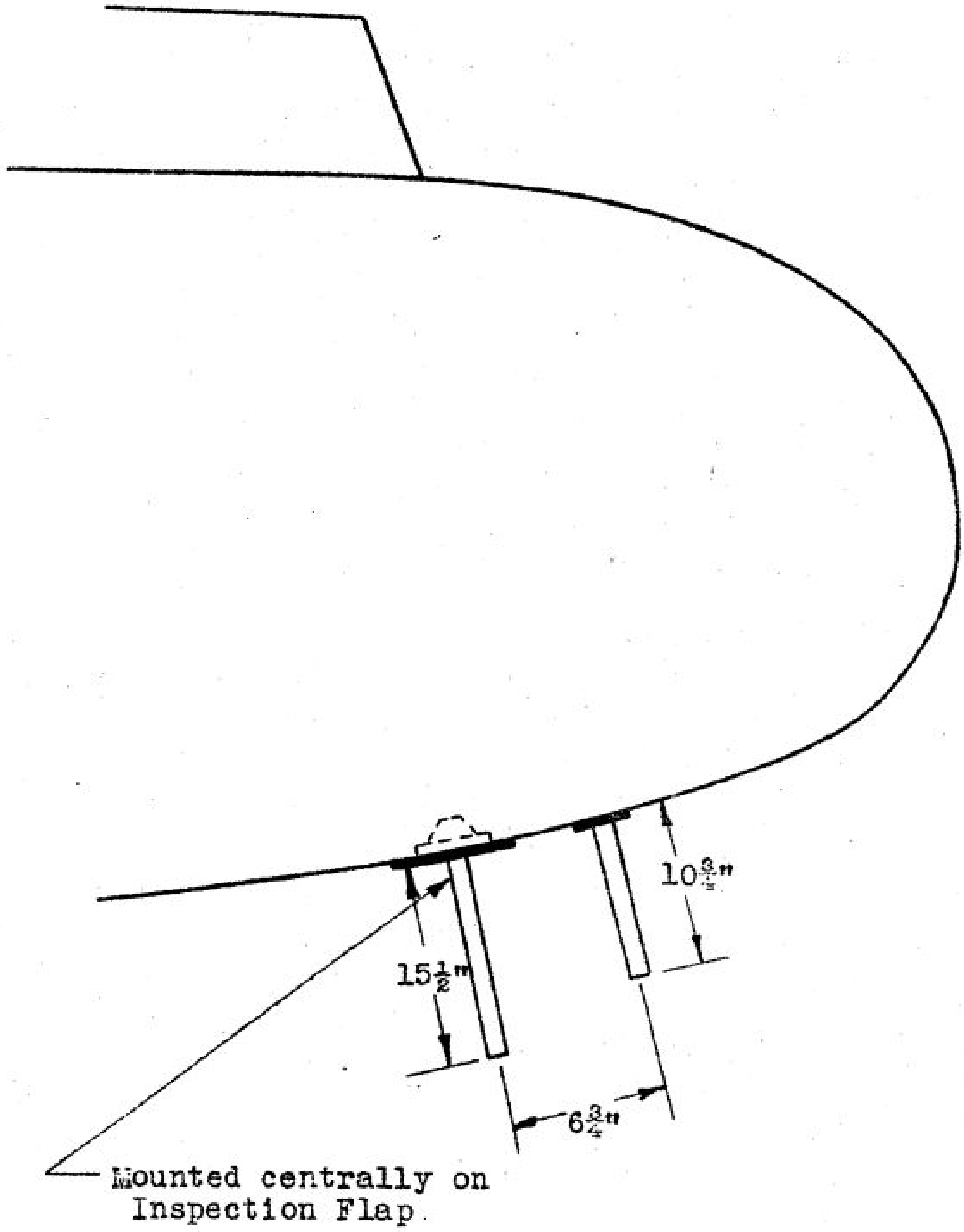


Fig. 33.