UNION LEAGUE CLUB OF CHICAGO
65 WEST JACKSON BOULEVARD
CHICAGO 4, ILLINOIS

Cancer & other deaths
only differ in importance
& to

all the rules — same thing in
same way

Shortly be filled
report incidents
happen in 100 [illegible]
in USA

UNION LEAGUE CLUB OF CHICAGO
65 WEST JACKSON BOULEVARD
CHICAGO 4, ILLINOIS

p. 97 – nothing in program
that anticipated

p 50 defined program as
Dunham & Ore
Rume
Katin

~~Def~~ Identified by documents
shown him –

Katin
ch KO
Dunham & Co

COMPETITOR PRODUCT ANALYSIS

12

PRODUCT: JFD - LPV-TV-16
DATE PERFORMED: 23 SEPT. '66

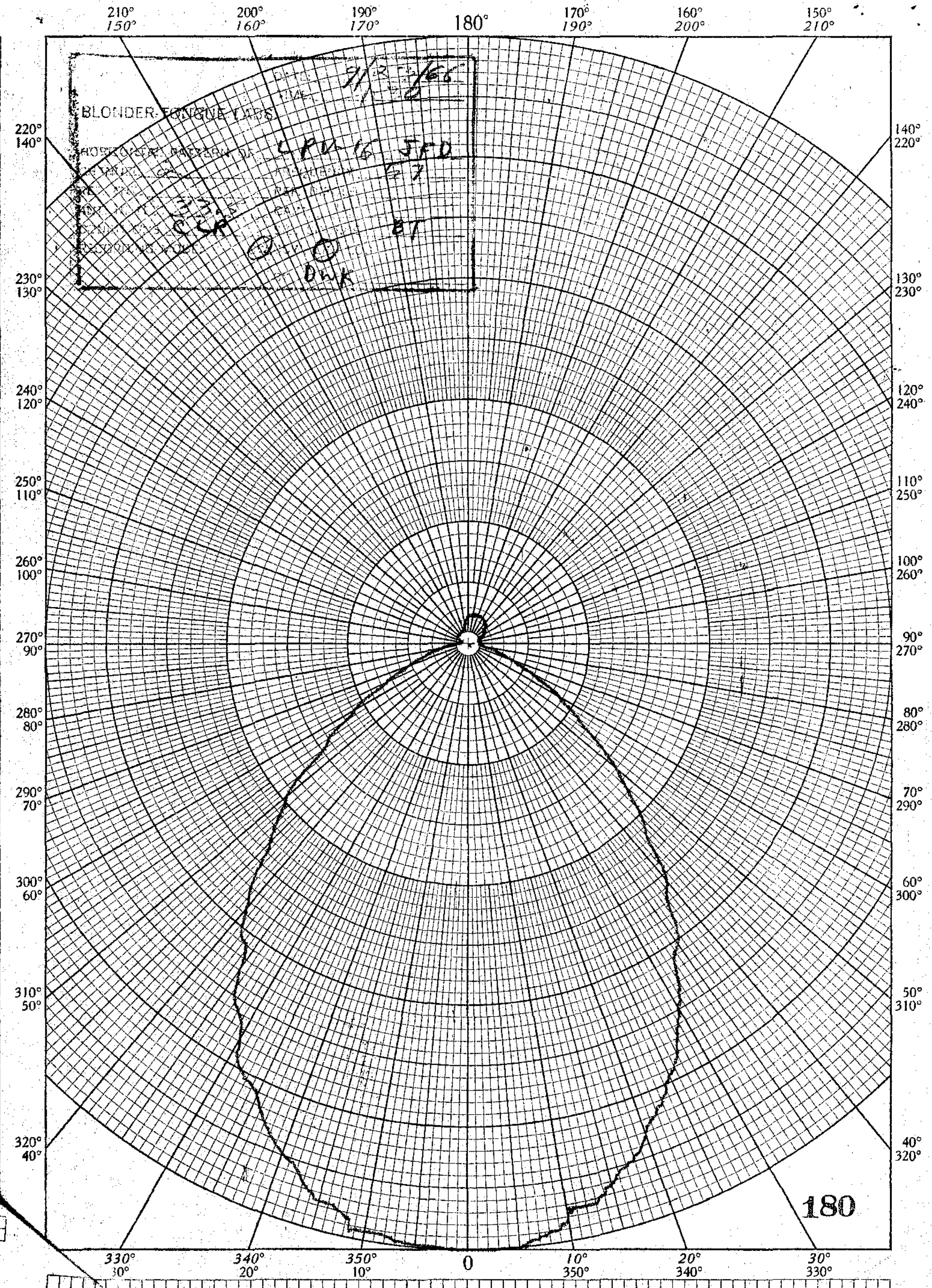
TESTS ON PATTERNS AND GAIN PERFORMANCE WERE MADE. FOR GAIN RESULTS SEE "ANTENNA RANGE MEASUREMENTS" BOOK #1

CONSTRUCTION: DUAL BOOM
" GOLD ALODIZING
11 ACTIVE ELEMENTS
5 PARASITIC

NOTE: 11 ELEMENTS ARE CAPACITIVE LOADED (6 ACTIVE & 5 PARASITIC)

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN

DEFENDANT EX. NO.__________
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER



BLONDER-TONGUE LABS

DATE 9/22/66

HORIZONTAL PATTERN OF CPU-16 JFD

27

335

CLR

0

0

BT

DWK

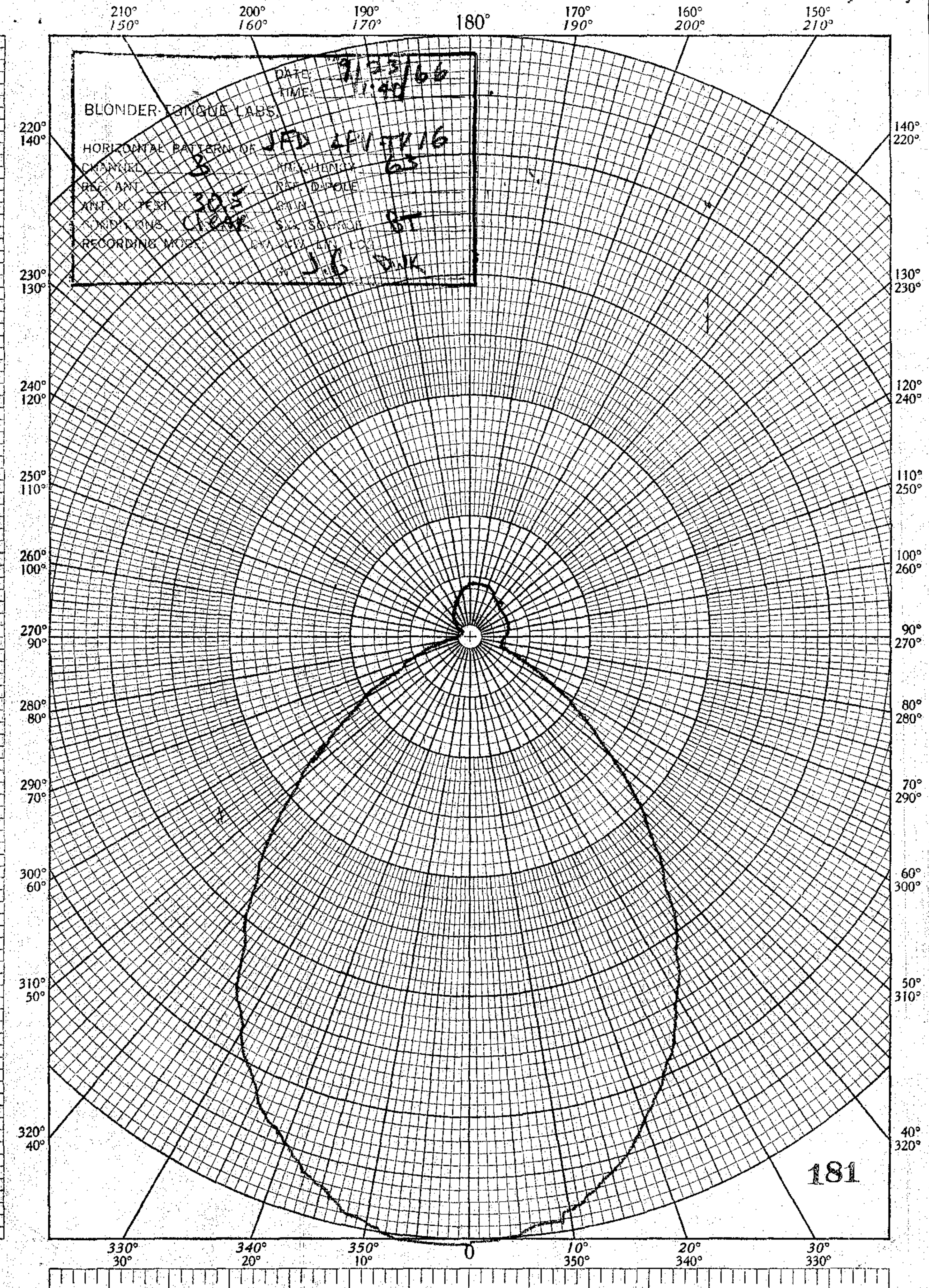
K+E POLAR CO-ORDINATE 46 4413 MADE IN U.S.A.

KEUFFEL & ESSER CO.

BLONDER-TONGUE LABS

DATE: 9/23/66
TIME: 1:40

HORIZONTAL PATTERN OF JFD LPV-TV16
CHANNEL 8 FREQUENCY 63
REF. ANT. REF. DIPOLE
ANT. U. TEST 30' GAIN
CONDITIONS Clear SIG. SOURCE 8T
RECORDING MODE: DB VOLT LIN LOG
BY J.G D.K.



BLONDER-TONGUE LABS.

DATE: 9/23/66

TIME: 11:45

HORIZONTAL PATTERN OF: JFD LPV-TV 16

CHANNEL: 4

FREQUENCY:

REF. ANT.:

REF. DIPOLE:

ANT. U. TEST: 32.5

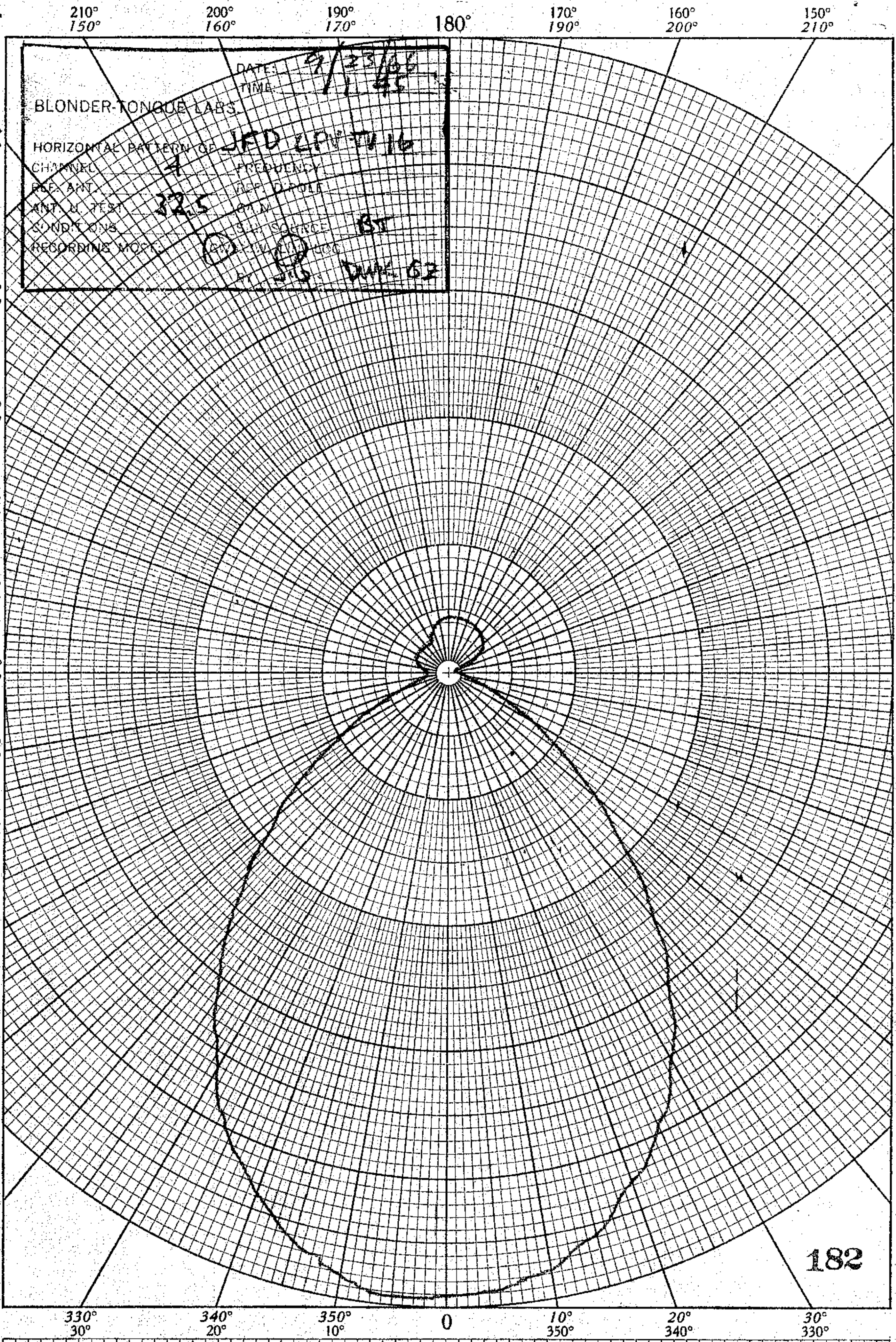
GAIN:

CONDITIONS:

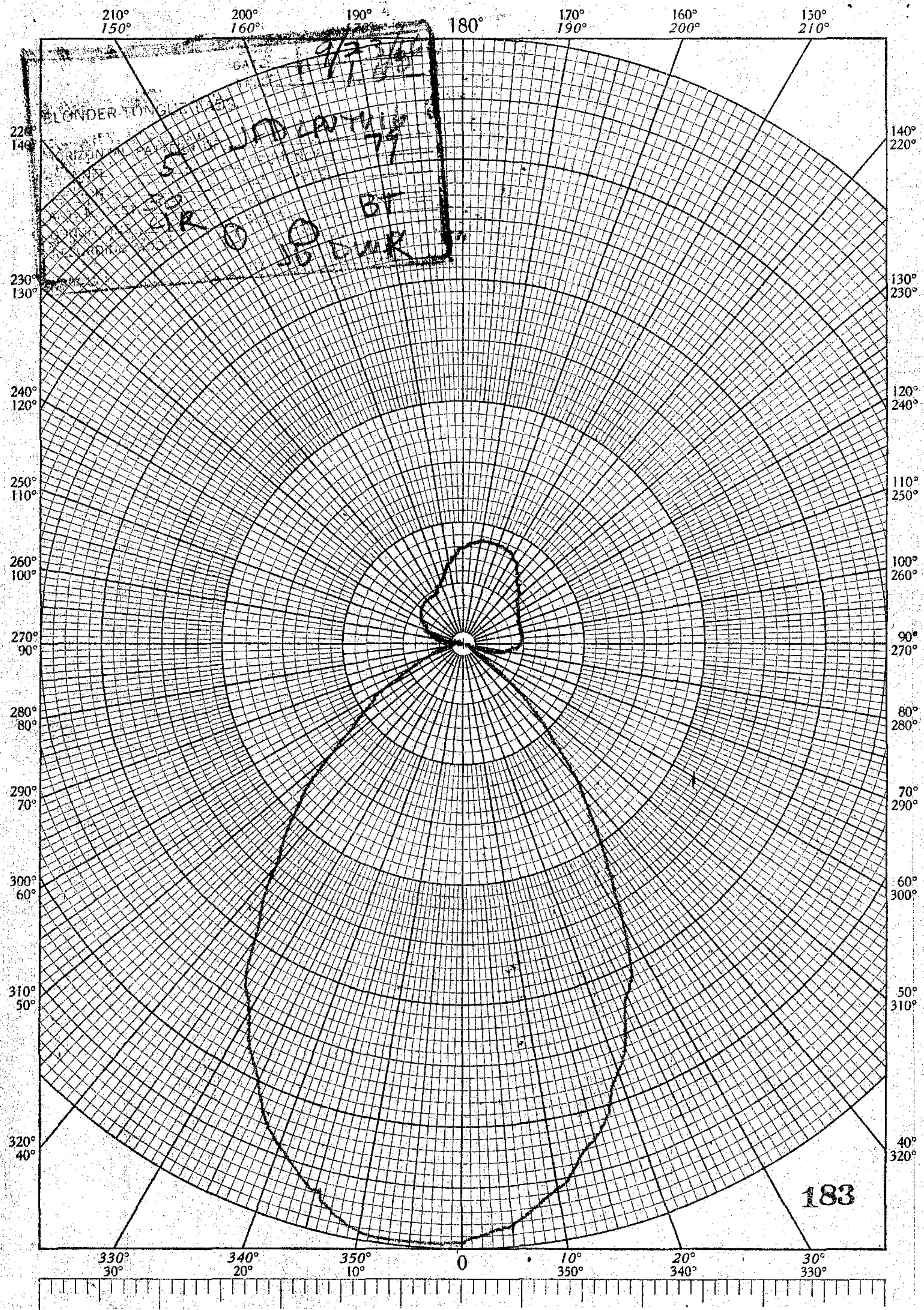
SIG. SOURCE: BT

RECORDING MODE: [✓ RV] V [✓ LIN] LOG

BY: DWK 62

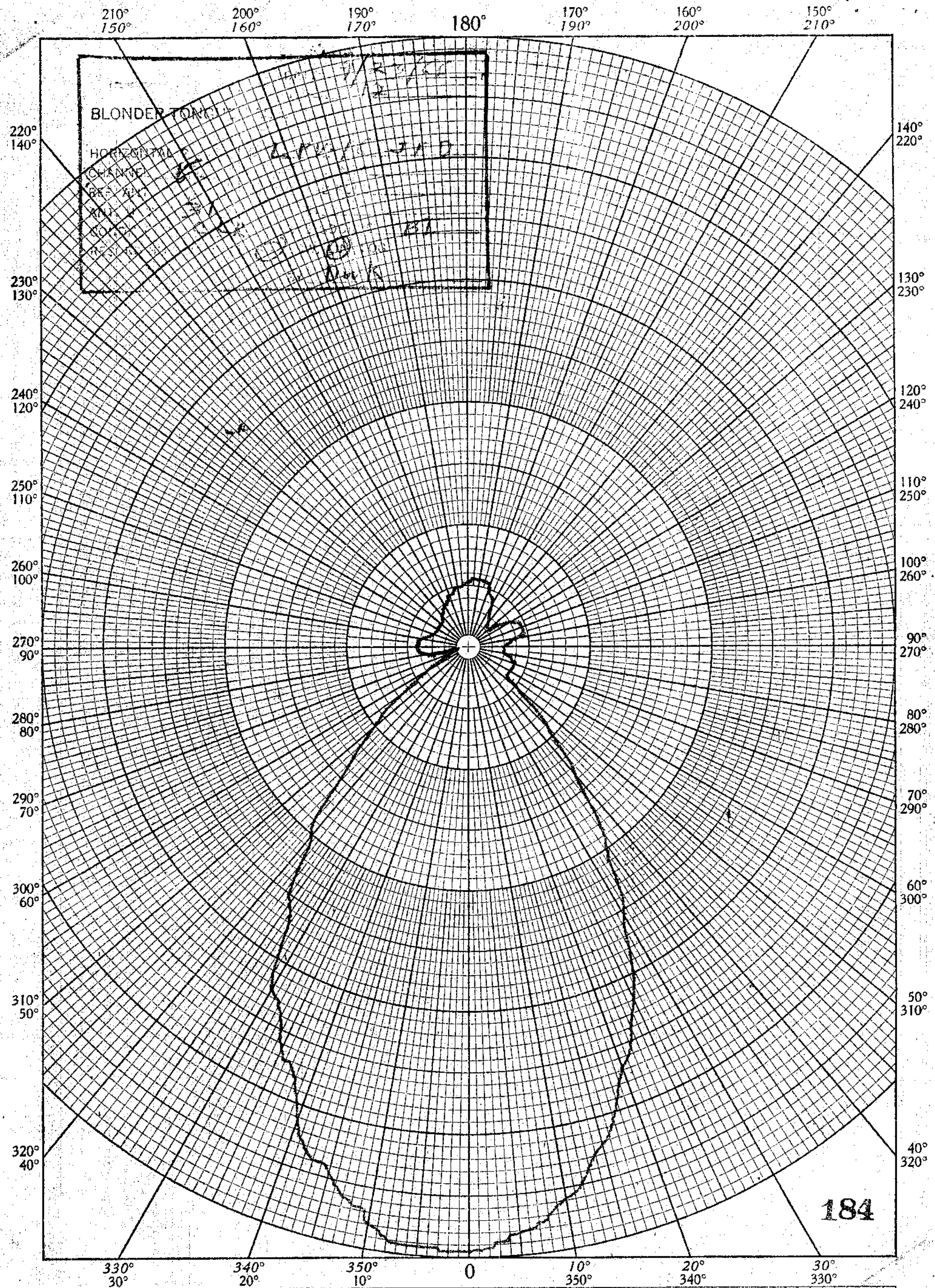


K+E POLAR CO-ORDINATE 46 4413 MADE IN U.S.A.
KEUFFEL & ESSER CO.



183

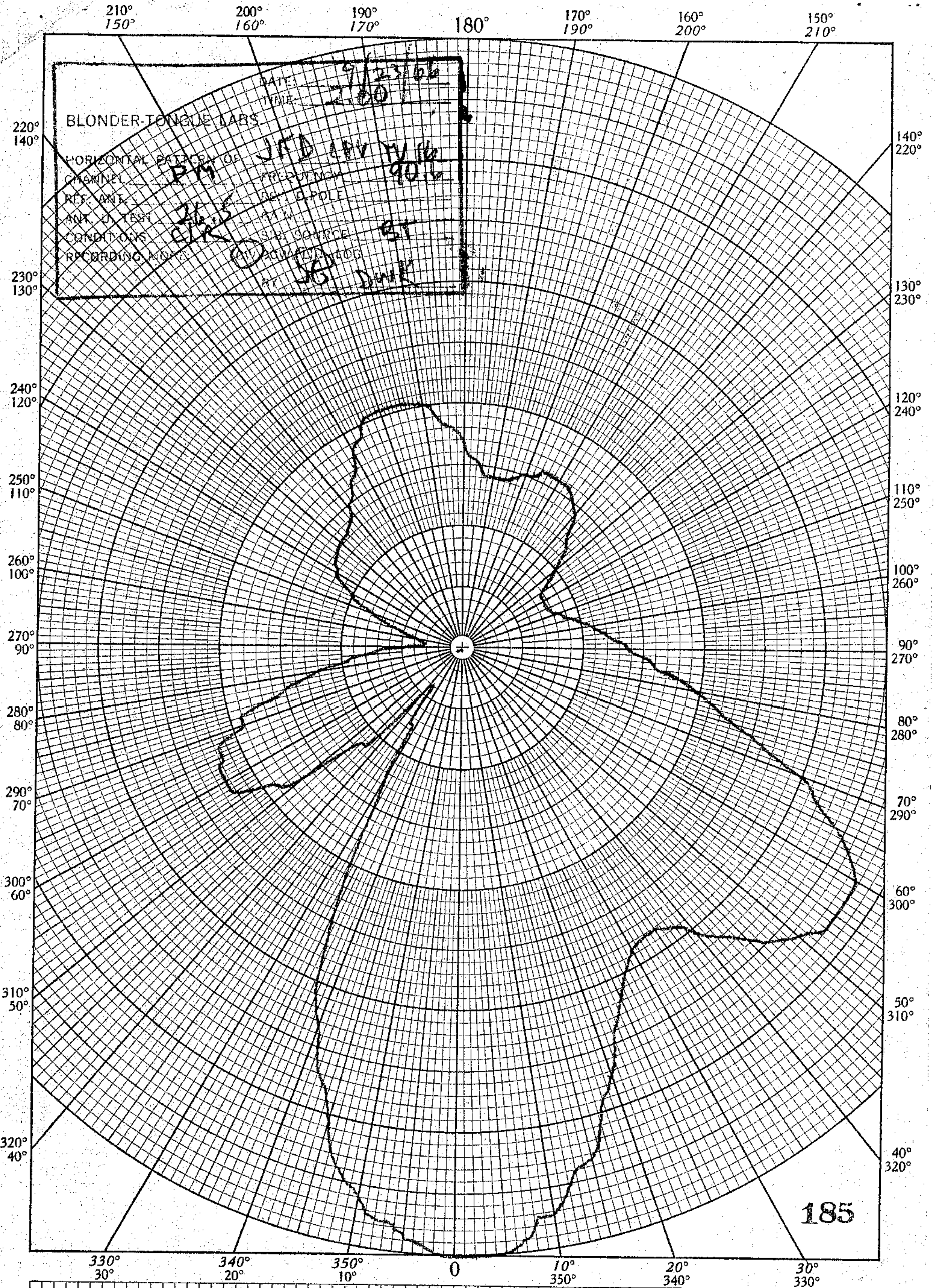
K&E POLAR CO-ORDINATE 46 4413
KEUFFEL & ESSER CO. MADE IN U.S.A.



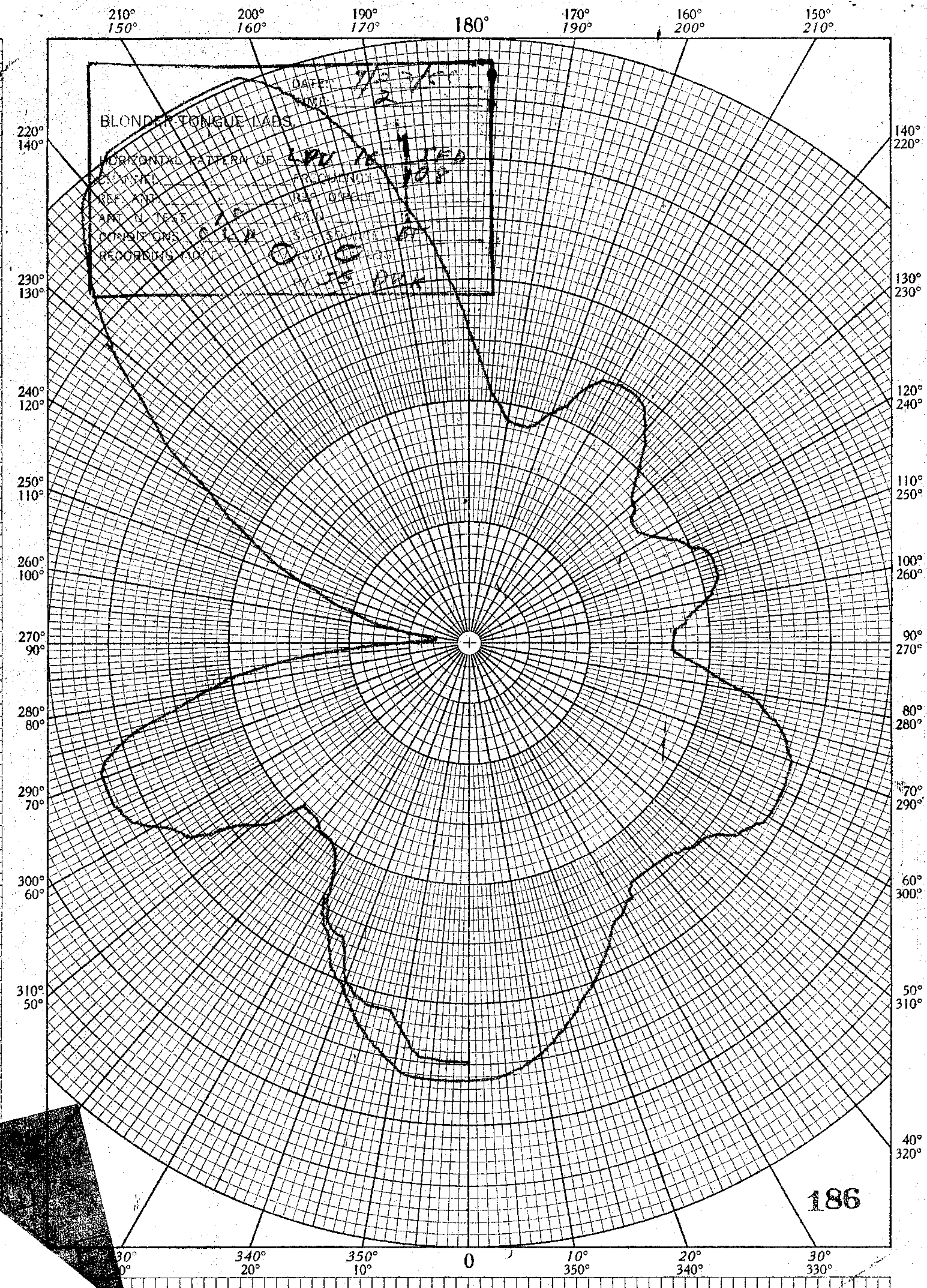
K+E POLAR CO-ORDINATE 46 4413 MADE IN U.S.A.
KEUFFEL & ESSER CO.

BLONDER-TONGUE LABS

DATE 9/23/66
TIME 2:00
HORIZONTAL PATTERN OF JFD LPV Yagi
CHANNEL FM
FREQUENCY 90 Mc
REF. ANT.
ANT. U. TEST 26.5
CONDITIONS CLR
SIG. SOURCE BT
RECORDING MODE [✓ AV] LIN LOG
BY SG DWK



185



DATE: 7/2/85
TIME:

BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF LPV 18 FED
CHANNEL
FREQUENCY 108
REF. ANT.
REF. DATA
ANT. U. TEST 18
GAIN
CONDITIONS C LW
SCALE 67
RECORDING NO.
O-C
JF Pak

BLONDER TONGUE LABS

DATE: 7/23/47

TIME: [illegible]

HORIZONTAL PATTERN OF [illegible]

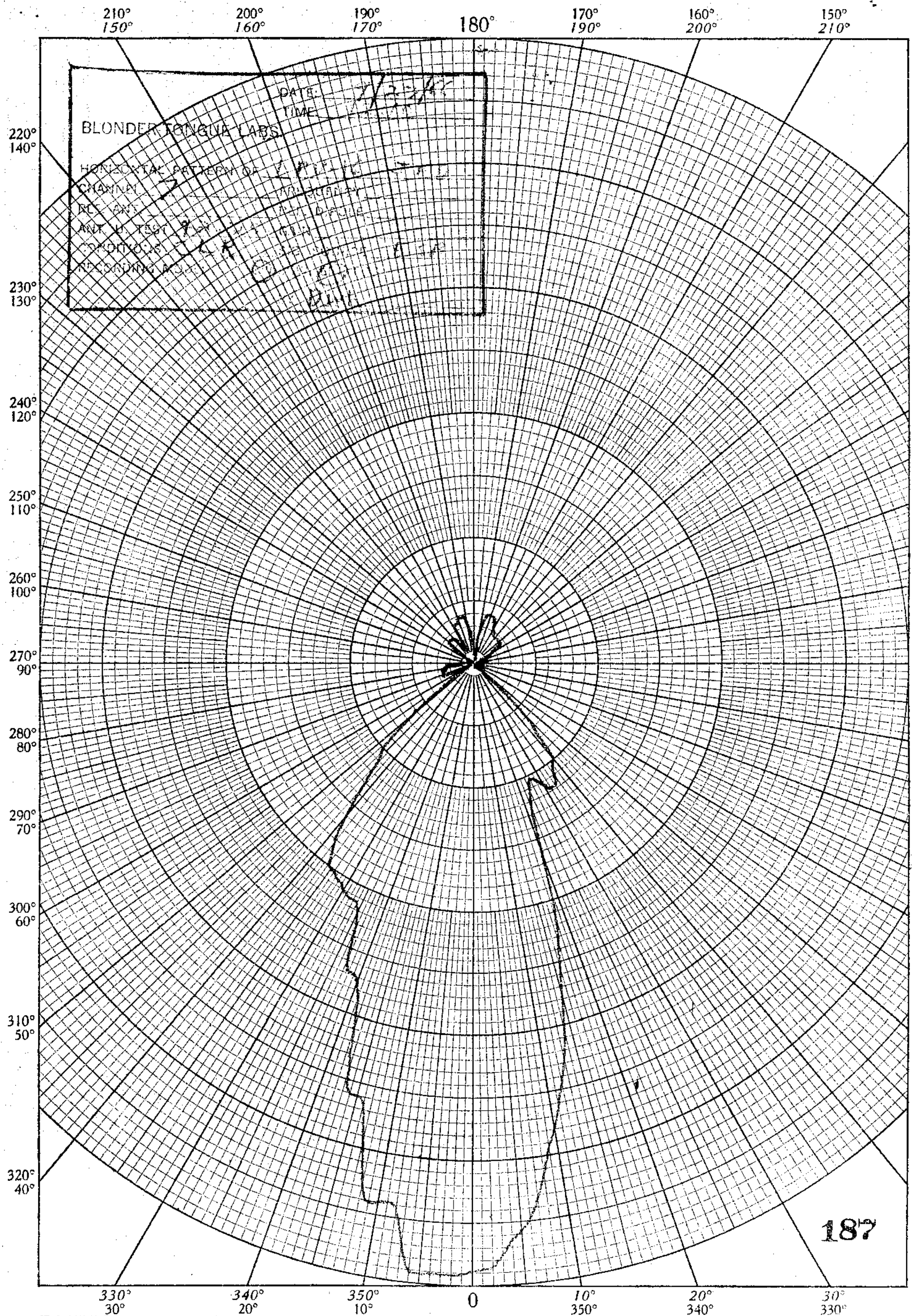
CHANNEL 7

REF. ANT. [illegible]

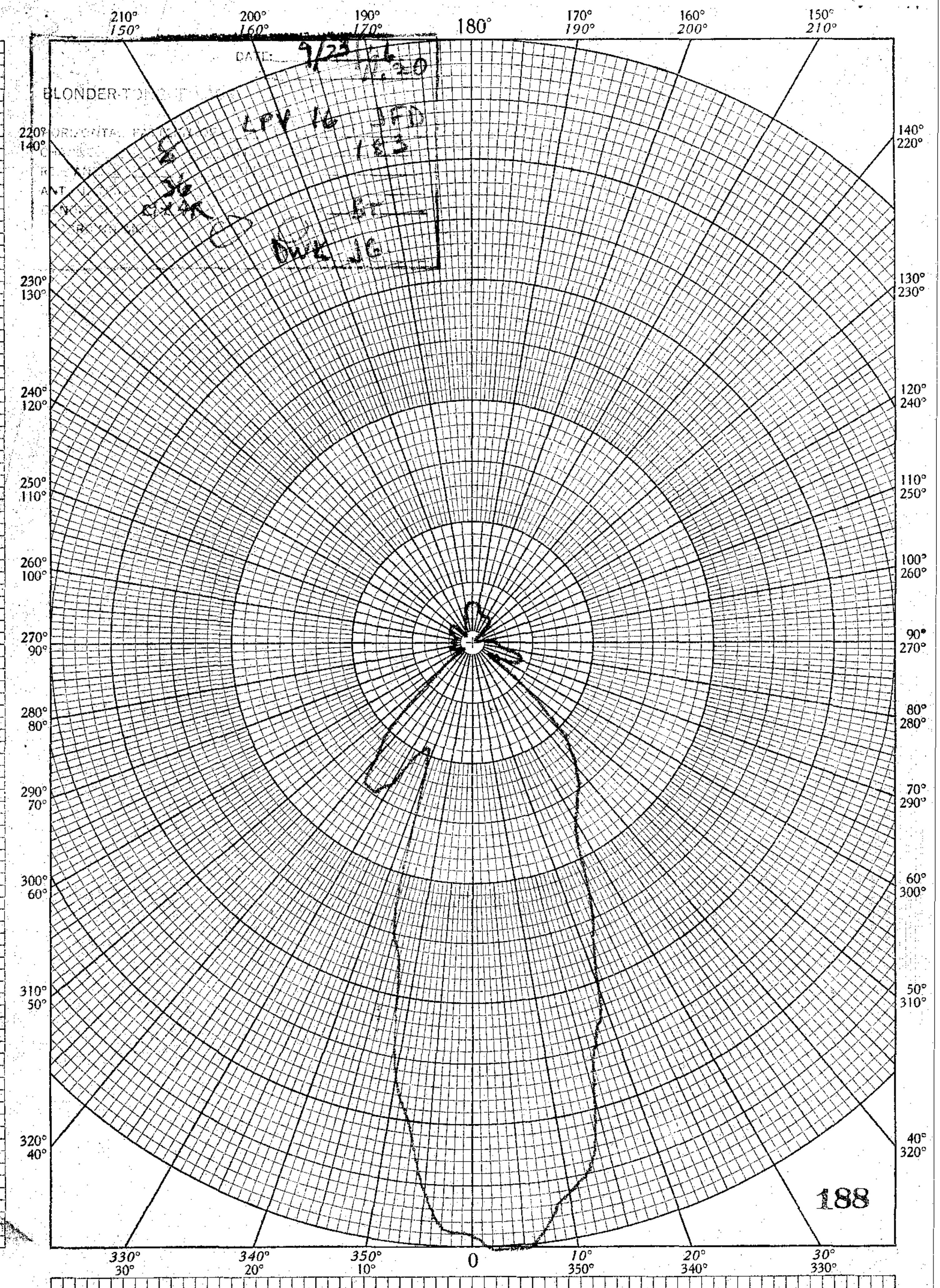
ANT. U. TEST [illegible]

CONDITIONS [illegible]

RECORDING [illegible]



187



9/23
N.20

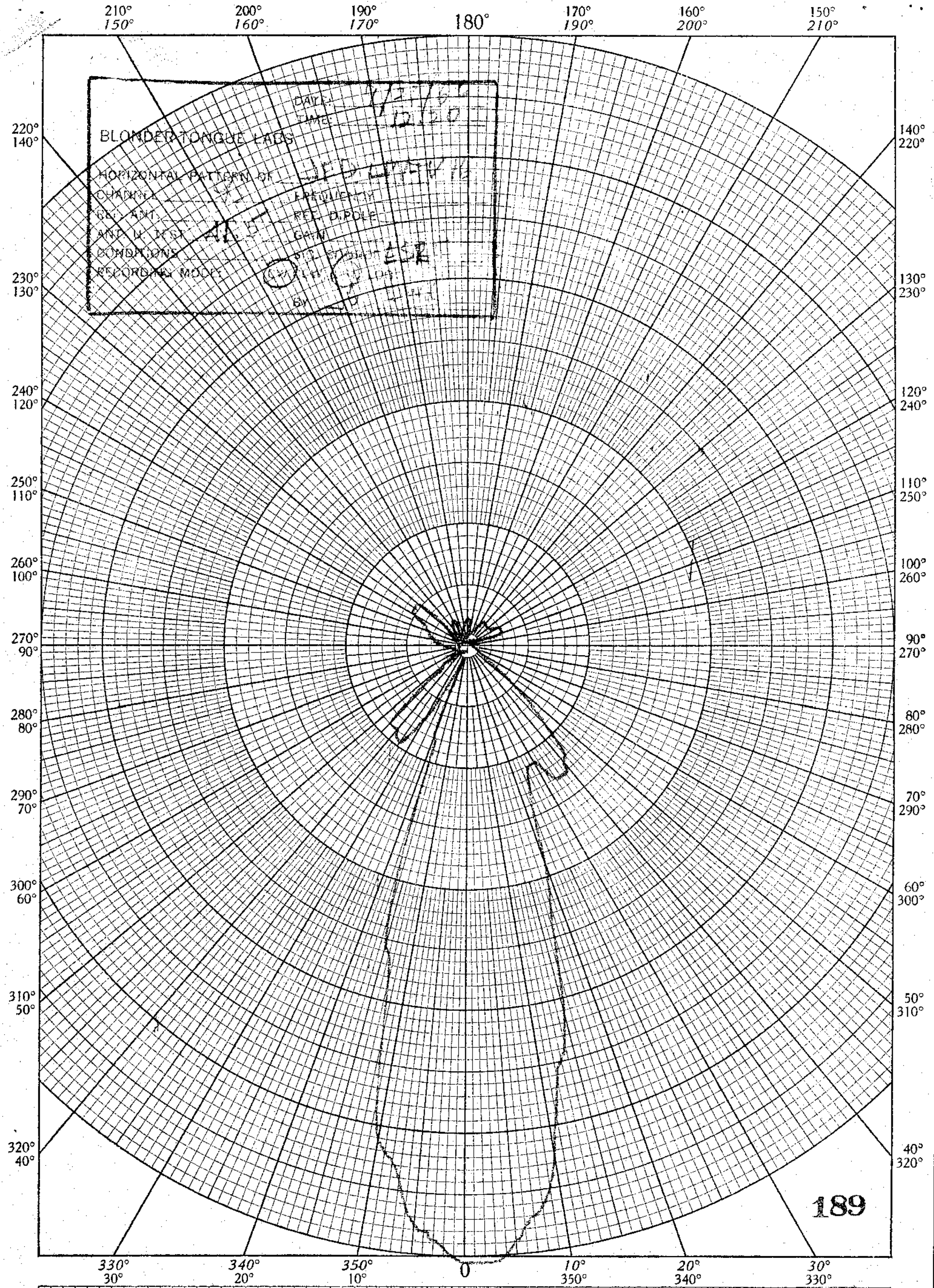
LPV 16 JFD
183

Ch
36
CXXR

6T

DWG JG

188



DATE 1/12/[illegible]
TIME 12:20

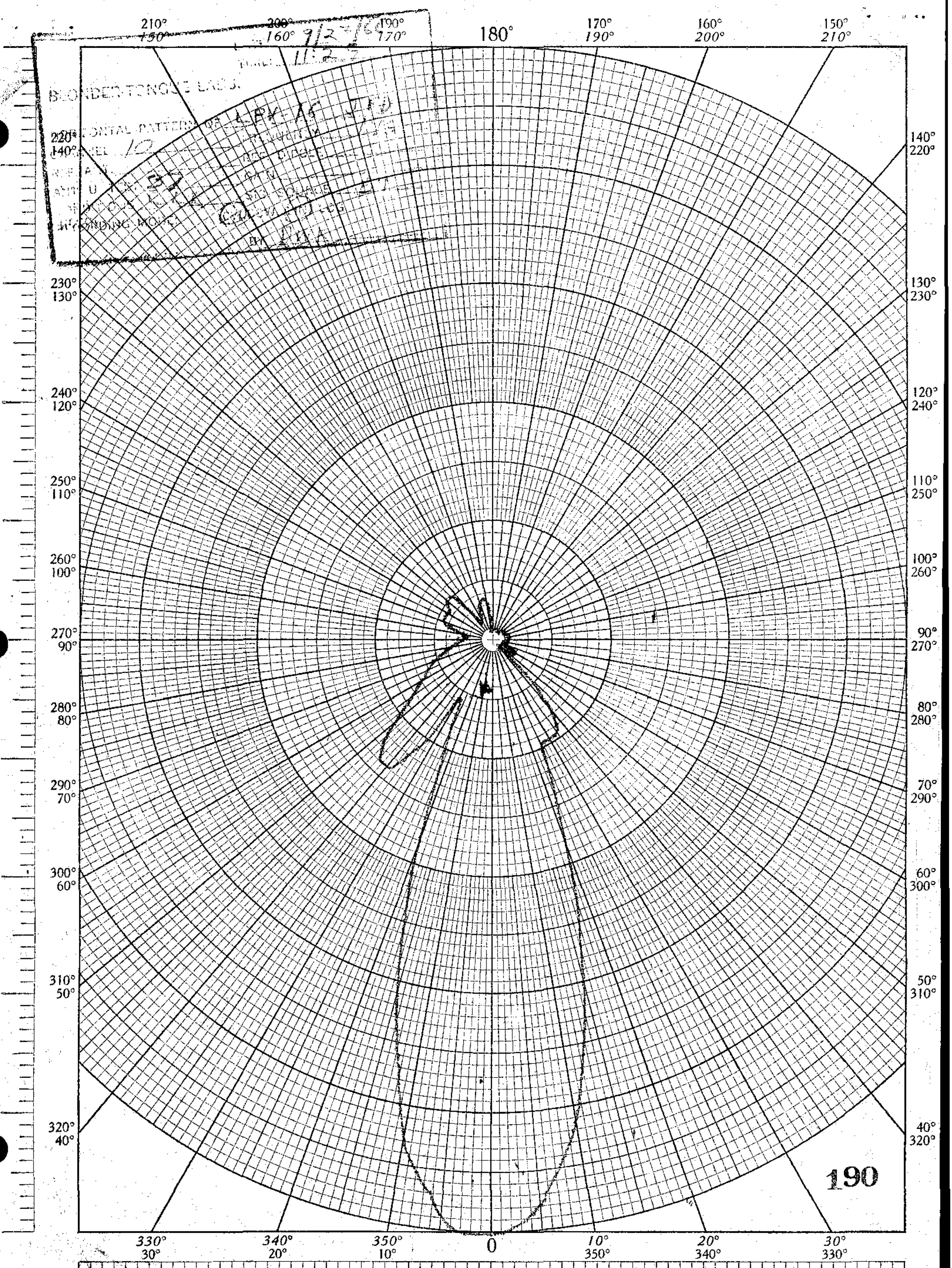
BLONDER TONGUE LABS

HORIZONTAL PATTERN OF [illegible]
CHANNEL [illegible]
FREQUENCY
REF. ANT.
REF. DIPOLE
ANT. U. TEST AC 5
GAIN
CONDITIONS
SIG. STRENGTH -45
RECORDING MODE [✓ CW] LIN [✓ LOG]
BY

K+E POLAR CO-ORDINATE 46 4413
MADE IN U.S.A.
KEUFFEL & ESSER CO.

9/27/60
11:25

BLONDER-TONGUE LABS.
HORIZONTAL PATTERN OF LPV-16 [illegible]
CHANNEL 10
[illegible]
[illegible]
[illegible]
WINDING MODE
FREQUENCY [illegible]
REF. DIPOLE
GAIN
SIG. SOURCE
BY [illegible]

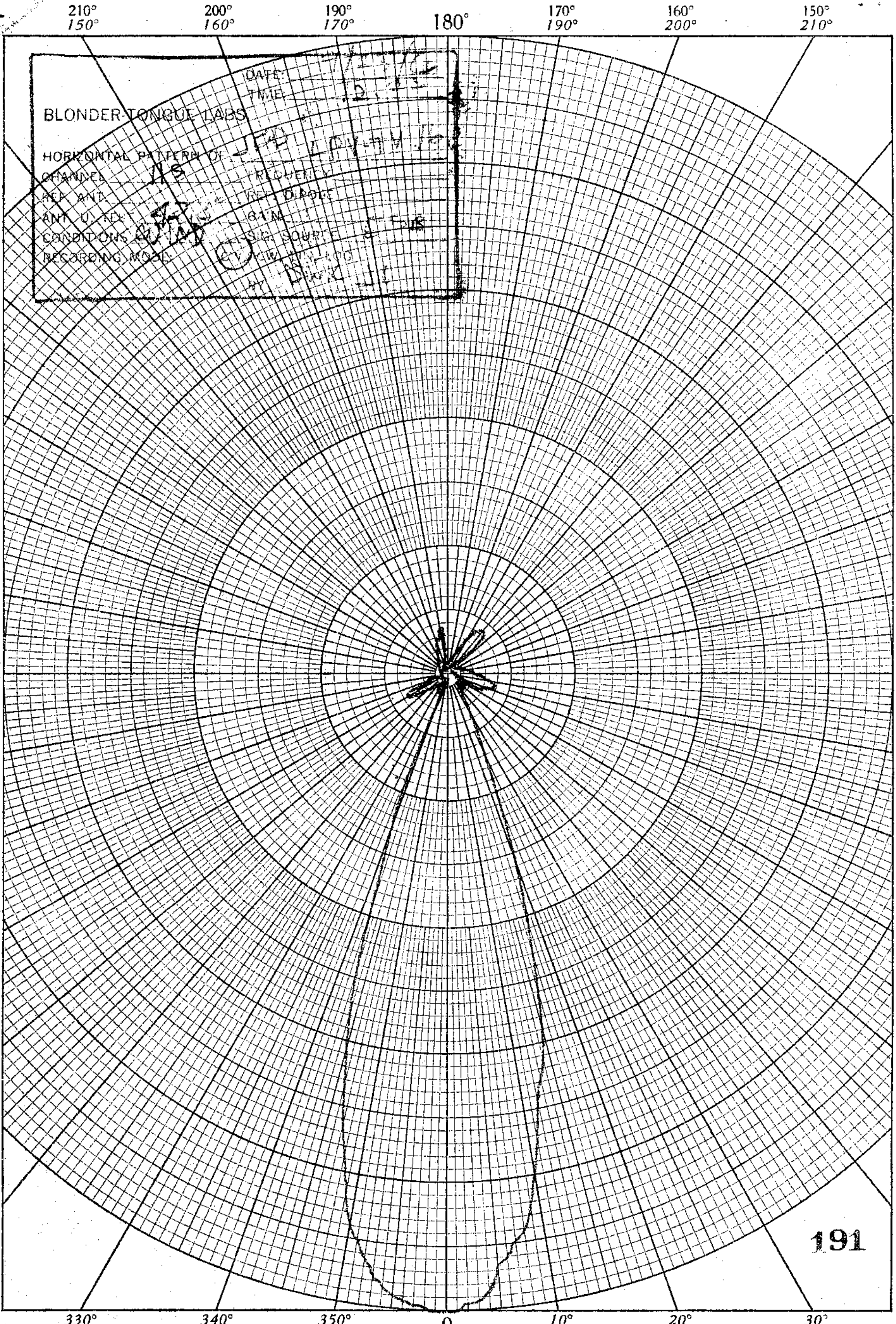


190

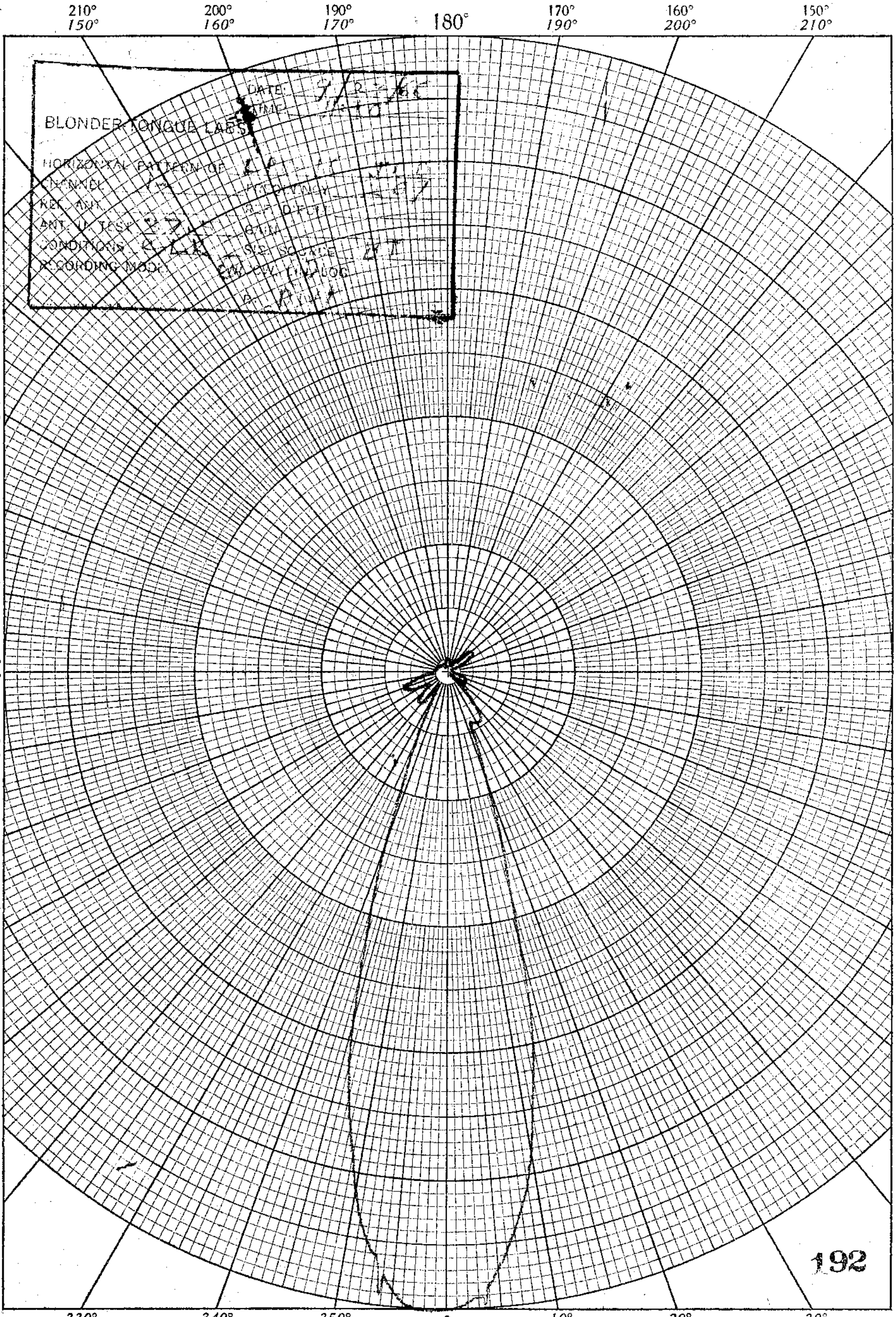
K+E POLAR CO-ORDINATE 46 4413
MADE IN U.S.A.
KEUFFEL & ESSER CO.

BLONDER-TONGUE LABS

DATE: 7/14/76
TIME:
HORIZONTAL PATTERN OF LPV-14
CHANNEL 11 S
FREQUENCY
REF. ANT.
REF. DIPOLE
ANT. U. TEST
GAIN 5 dB
CONDITIONS
SIG. SOURCE
RECORDING MODE [✓ CV] CW LIN LOG
BY



K+E POLAR CO-ORDINATE 46 4413
MADE IN U.S.A.
KEUFFEL & ESSER CO.



BLONDER-TONGUE LABS

DATE [illegible]

TIME [illegible]

HORIZONTAL PATTERN OF [illegible]

CHANNEL [illegible]

FREQUENCY [illegible]

REF. ANT.

R.F. DETECT.

ANT. U. TEST [illegible]

GAIN

CONDITIONS [illegible]

SIG. SOURCE [illegible]

RECORDING MODE

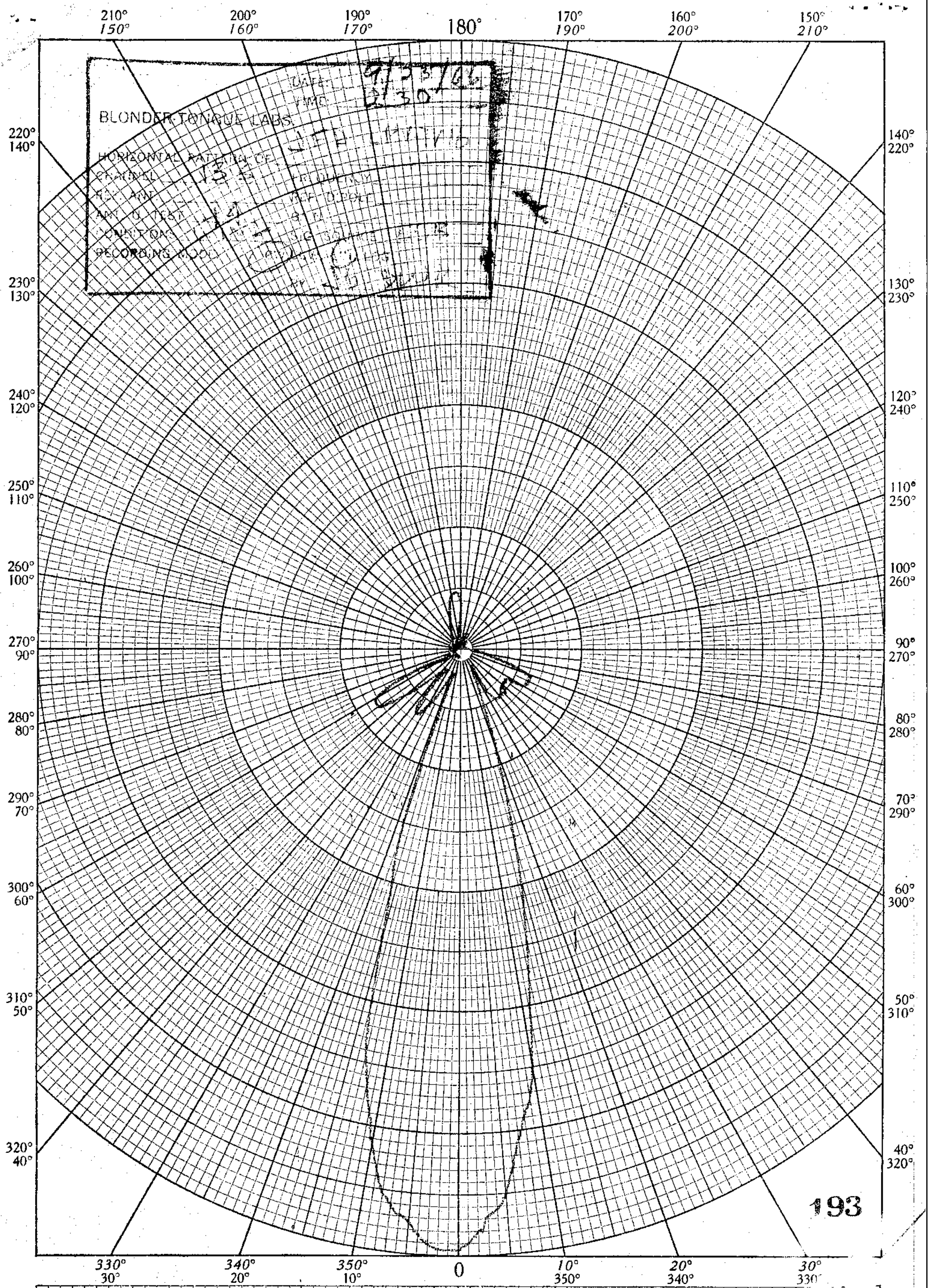
CW ☐ CW ☐ LOG

[illegible]

DATE 9/3/64
TIME 2:30

BLONDER TONGUE LABS

HORIZONTAL PATTERN OF [illegible]
CHANNEL 13 FREQUENCY [illegible]
REF. ANT. REF. DIPOLE
ANT. U. TEST [illegible]
CONDITIONS [illegible]
RECORDING MODE [illegible]



(13) LPVU-12

PREPARED BY: AS
12/65

COMPETITIVE PRODUCT EVALUATION

1. SUBJECT: JFD ANTENNA.
2. MODEL: LPV-VU12 CAP ELECTRONIC DIPOLE LOG PERIODIC VHF/UHF/FM ANT.
3. LIST PRICE: $49.95
4 PATENTS CLAIMED: 2,958,081 2,985,879 3,011,168 3,108,280 3,150,376
ADDITIONAL PATENTS PENDING (US & CANADA).
UNDER EXCLUSIVE LICENSE FROM THE UNIVERSITY OF ILL. FOUNDATION.
5. ACCESSORIES SUPPLIED; VHF/UHF/FM SPLITTER/COUPLER, INSTRUCTION SHEET.
6. CARTON; THREE COLOR DISPLAY 11'5" LONG.
7. TOTAL BOOM LENGTH; 8'9".
8. FINISH: "GOLD ALODIZING"
9. INSULATION MATERIAL; IMPLEX A ACRYLIC.
10. ELEMENT MATERIAL: ALUMINUM, 3/8" WITH SEAMS.
11. BOOM MATERIAL: ALUMINUM, 3/4" x 3/4"
12. MOUNTING; TWO "U" BOLTS.

13. PERFORMANCE: (ALL MEASURMENTS DONE WITHOUT COUPLER SUPPLIED)

13.1 GAIN; OVER A TUNED DIPOLE

CH. OR FREQ.	2	3	4	5	6	90.6	110	7	8	9	10	11	12	13	470	560	660	760	890
DB GAIN	3.9	3.6	3.7	3.5	3	≃2.0	-9.0	6.2	8.0	9.9	7.5	9.6	5.6	7.2	8.0	7.4	10.0	5.5	4.5

13.2 VSWR:

13.2.1	54 - 88 MC	3.5	MATCH; 1.8:1
13.2.2	88 - 108 MC	13	1.2:1
13.2.3	174 - 216 MC	2.3	2.4:1
13.2.4	470 - 890 MC	4.5	1.6:1

13.3 FRONT TO BACK RATIO:

13.3.1 54 - 88 MC 13 dB - 20 dB
13.3.2 88-108 MC 8 dB - 17 dB
13.3.3 174-216 MC 14 dB - 30 dB
13.3.4 465 - 890 MC 8.5 dB - 30 dB
13.3.5 SIDE LOBE REJECTION 174-216 MC -9.5 dB OR BETTER
13.3.6 ✓ ✓ ✓ 465-890 MC - 5.0 dB OR BETTER

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
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DEFENDANT EX. NO.______
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OFFICIAL COURT REPORTER

13.4 HORIZONTAL BEAMWIDTH (E-PLANE 3.0 dB POINTS)

13.4.1 54 - 88 MC, 66° - 78°
13.4.2 174 - 216 MC 26° - 30°
13.4.3 465 - 890 MC 17° - 45°

14. CONCLUSION

14.1 LOW-BAND PERFORMANCE: OPERATING AT $\frac{\lambda}{2}$ MODE THE VSWR, GAIN AND PATTERN ARE TYPICAL FOR THIS MODE. GAIN HOWEVER IS SLIGHTLY LOW AND FRONT TO BACK RATIO IS NOT TOO GOOD.

14.2 FM PERFORMANCE: GAIN DROPS FROM +2.0 dB AT 90.6MC TO APP. − 8.0dB AT 108MC. THE PATTERN DETERIORATES AT THE HIGH END OF THE FM AND THE VSWR IS VERY POOR.

14.3 HIGH-BAND PERFORMANCE; VSWR AND PATTERN ARE TYPICAL FOR THE $3/2\ \lambda$ MODE OPERATION. THE GAIN VARIES FROM A LOW OF 6.2 dB TO A HIGH OF 9.9 dB.

14.4 UHF PERFORMANCE: VERY NARROW PATTERN AT SOME POINTS ($\frac{7}{2}\lambda$ TO $\frac{9}{2}\lambda$ MODE OF OPERATION) GAIN VARIES FROM 10 dB AT THE CENTER OF THE BAND TO A LOW OF 4.5 dB AT THE HIGH END.
THE PATTERN DETERIORATES FROM APPR. 700 MC AND UP.
ANTENNA POSITIONING IS VERY CRITICAL FOR THE HIGH GAIN PORTION OF THE BAND (17.0° BEAMWIDTH)

14.5 INSTALLATION IS QUITE SIMPLE. THE DOWN LEAD IS CONNECTED TO A SPECIAL TRANSMISSION LINE SECTION.
THE NEW SNAP-IN MECHANISM IS QUITE SLOPPY IN TOLERANCE PERMITTING THE DIPOLES TO WOBBLE
SLOPPY AND LOOSE RIVITING PERMITS NOISY DIPOLE CONNECTIONS TO BOOM.

14.6 FOR PERFORMANCE OF VHF/UHF/FM INDOOR COUPLER AC-80, SEE COMPETITIVE PRODUCT ANALYSIS 1/5/65.

(3)

DATE: 5/10/63
TIME: 10:25

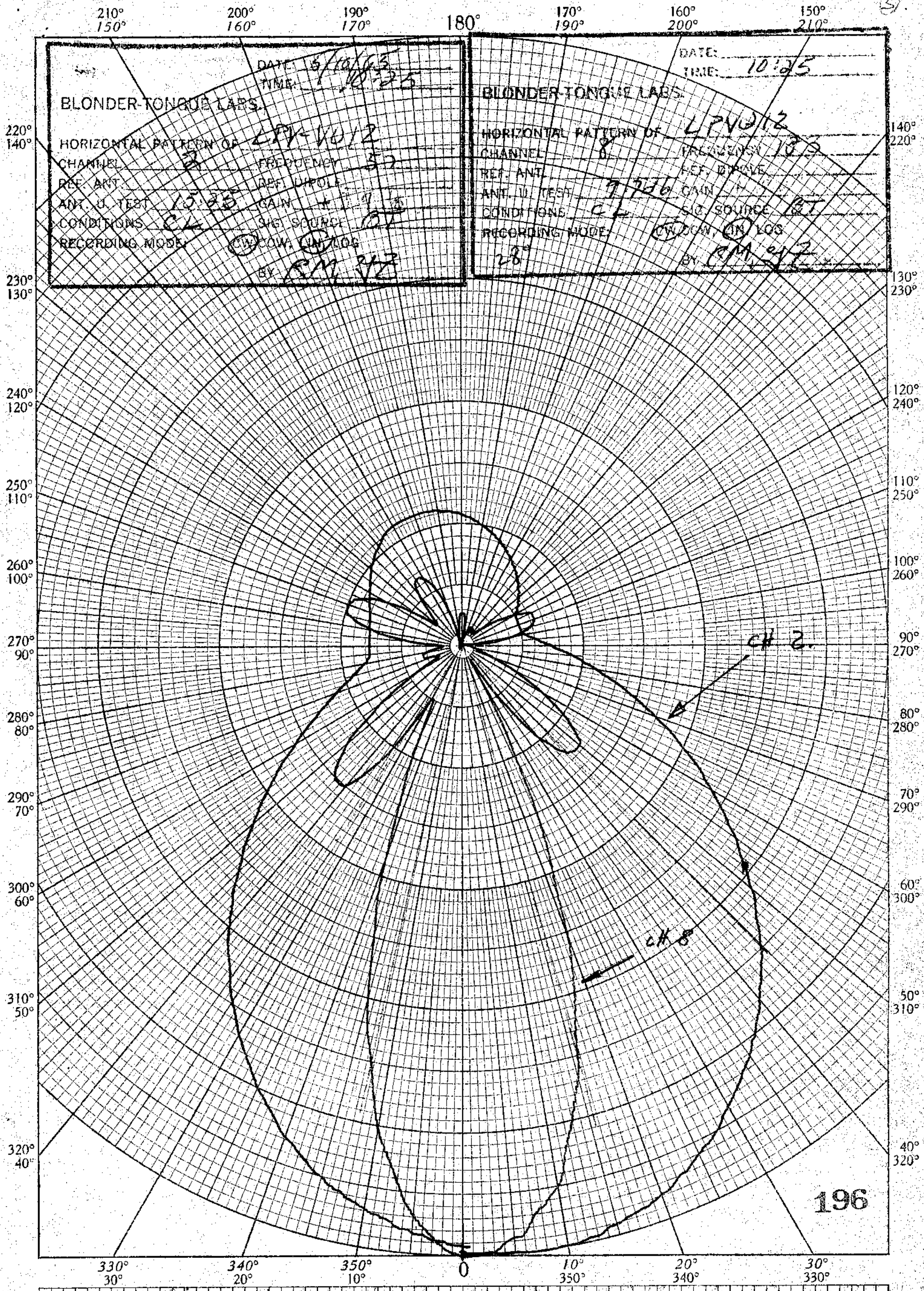
BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF LPV-V012
CHANNEL 2 FREQUENCY 57
REF. ANT. REF. DIPOLE
ANT. U. TEST 15 25 GAIN +1.1
CONDITIONS CL SIG. SOURCE BT
RECORDING MODE: [✓ CW], CCW, [✓ LIN], LOG
BY CM 42

DATE:
TIME: 10:25

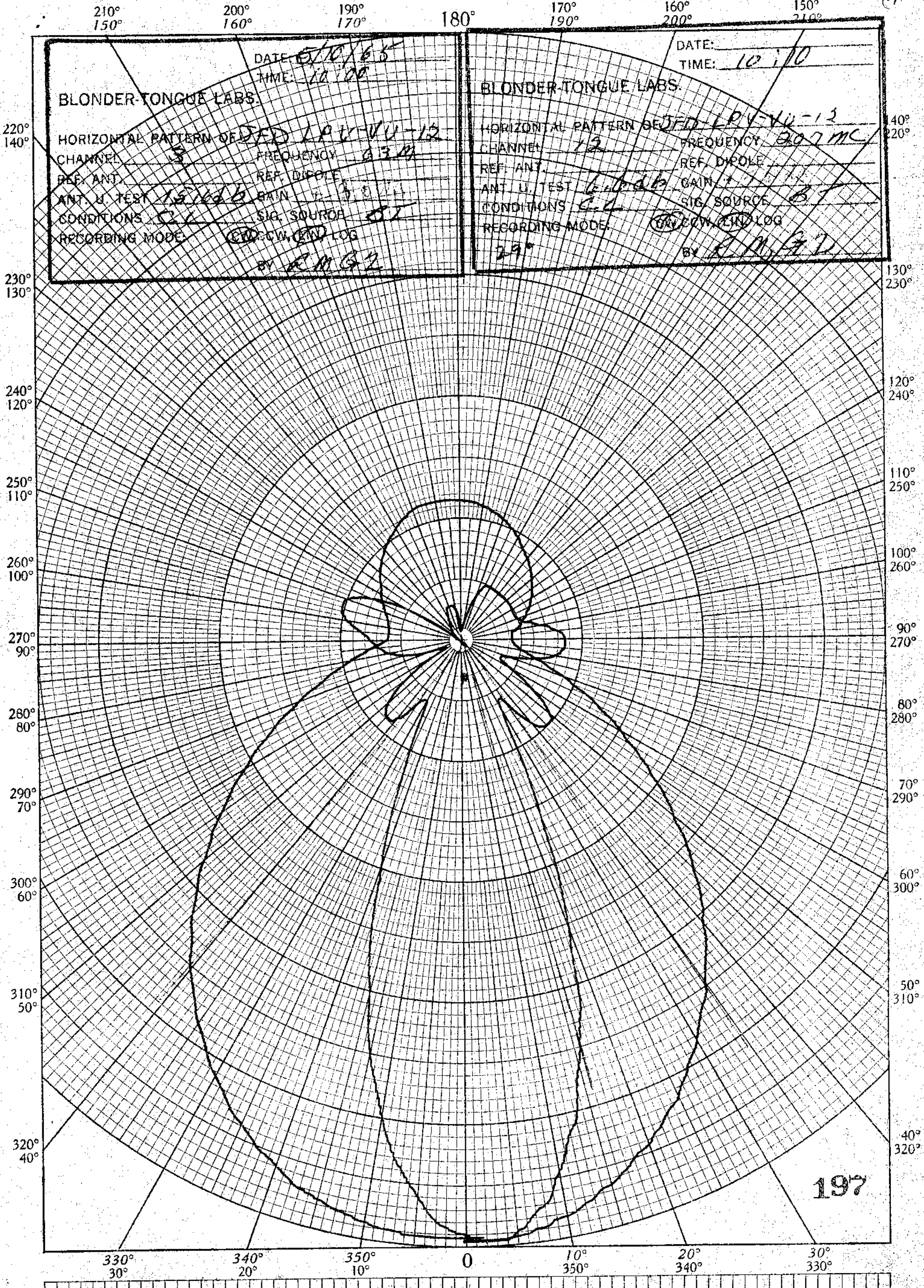
BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF LPV012
CHANNEL 8 FREQUENCY 183
REF. ANT. REF. DIPOLE
ANT. U. TEST 7 726 GAIN
CONDITIONS CL SIG. SOURCE BT
RECORDING MODE: [✓ CW], CCW, [✓ LIN], LOG
28°
BY CM 42



196

(4)



DATE: 5/10/65
TIME: 12:00

BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF JFD LPV-VU-12
CHANNEL 3
FREQUENCY 63M
REF. ANT.
REF. DIPOLE
ANT. U. TEST 15.6db
GAIN + 5.0
CONDITIONS CL
SIG. SOURCE BT
RECORDING MODE: [✓ CW] CCW [✓ LIN] LOG
BY RMG2

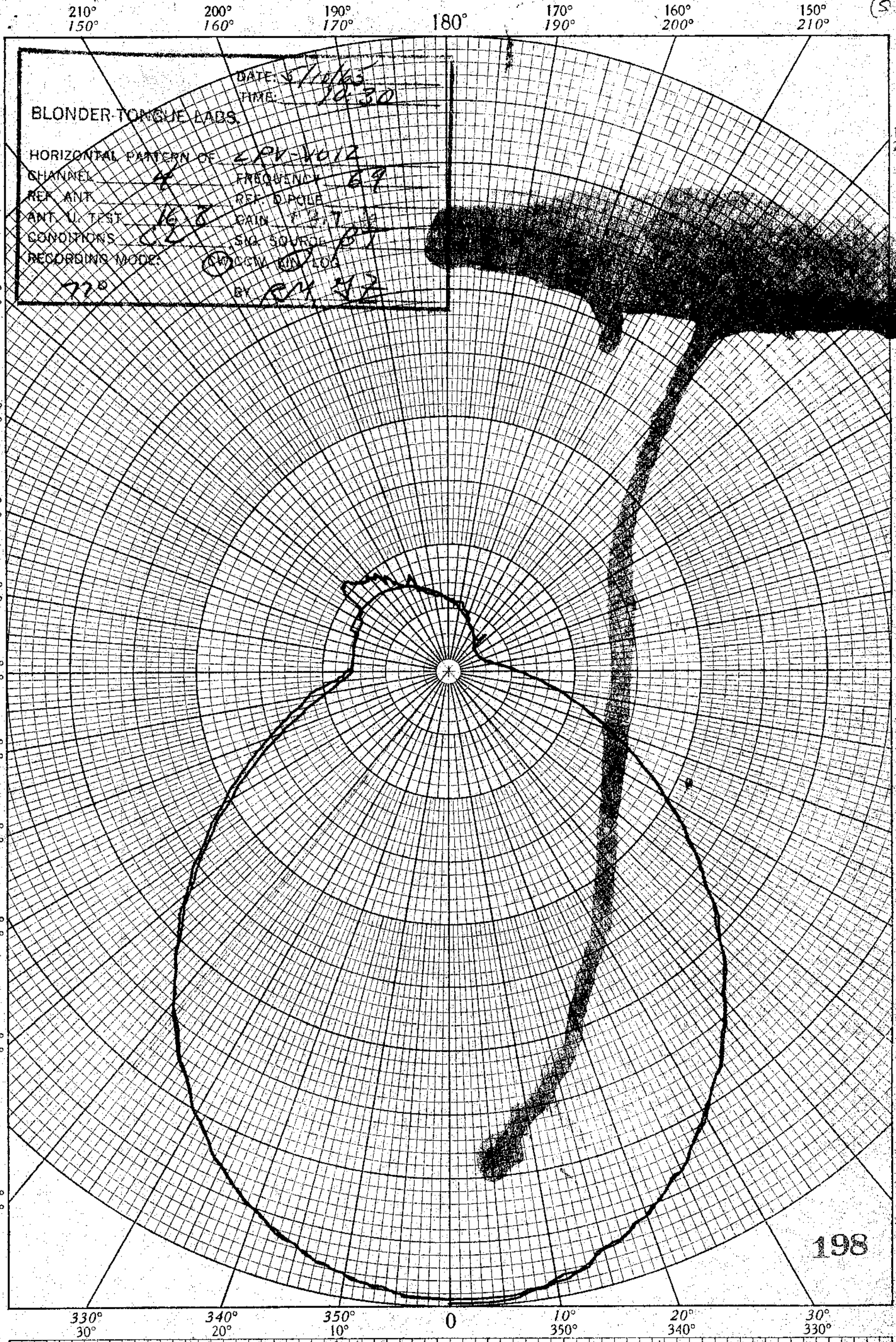
DATE:
TIME: 10:10

BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF JFD LPV-VU-12
CHANNEL 12
FREQUENCY 207 MC
REF. ANT.
REF. DIPOLE
ANT. U. TEST 6.0db
GAIN
CONDITIONS CL
SIG. SOURCE BT
RECORDING MODE: [✓ CW] CCW [✓ LIN] LOG
29°
BY RMG2

197

(5



DATE: 5/1/63

TIME: 10:30

BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF LPV-VU12

CHANNEL 4 FREQUENCY 67

REF. ANT. REF. D POLE

ANT. U. TEST 16 B GAIN 7.7

CONDITIONS CL SIG. SOURCE BT

RECORDING MODE: [✓ CW] CCW [✓ LIN] LOG

72°

BY RM JZ

K&E POLAR CO-ORDINATE 46 4412 KEUFFEL & ESSER CO. MADE IN U.S.A.

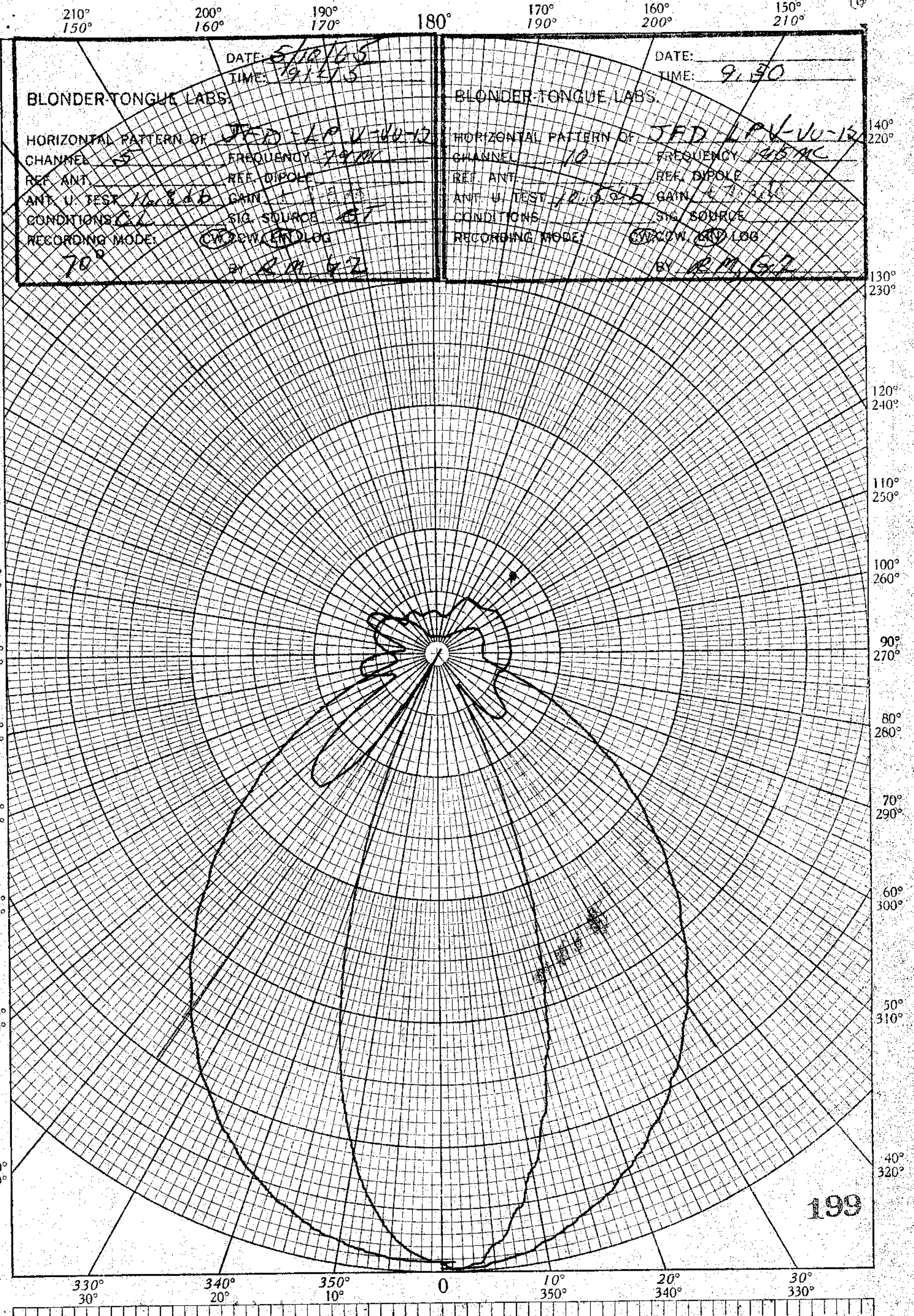
(6)

BLONDER-TONGUE LABS.

DATE: 5/10/65
TIME: 9,15
HORIZONTAL PATTERN OF JFD-LPV-VU-12
CHANNEL 5 FREQUENCY 79 MC
REF. ANT. REF. DIPOLE
ANT. U. TEST 16.8 db GAIN [illegible]
CONDITIONS CL SIG. SOURCE BT
RECORDING MODE: [✓ CW] CCW [✓ LIN] LOG
70°
BY RM GZ

BLONDER-TONGUE LABS.

DATE:
TIME: 9,30
HORIZONTAL PATTERN OF JFD LPV-VU-12
CHANNEL 10 FREQUENCY 195 MC
REF. ANT. REF. DIPOLE
ANT. U. TEST 10.3 db GAIN 4.7 db
CONDITIONS SIG. SOURCE
RECORDING MODE: [✓ CW] CCW [✓ LIN] LOG
BY RM GZ

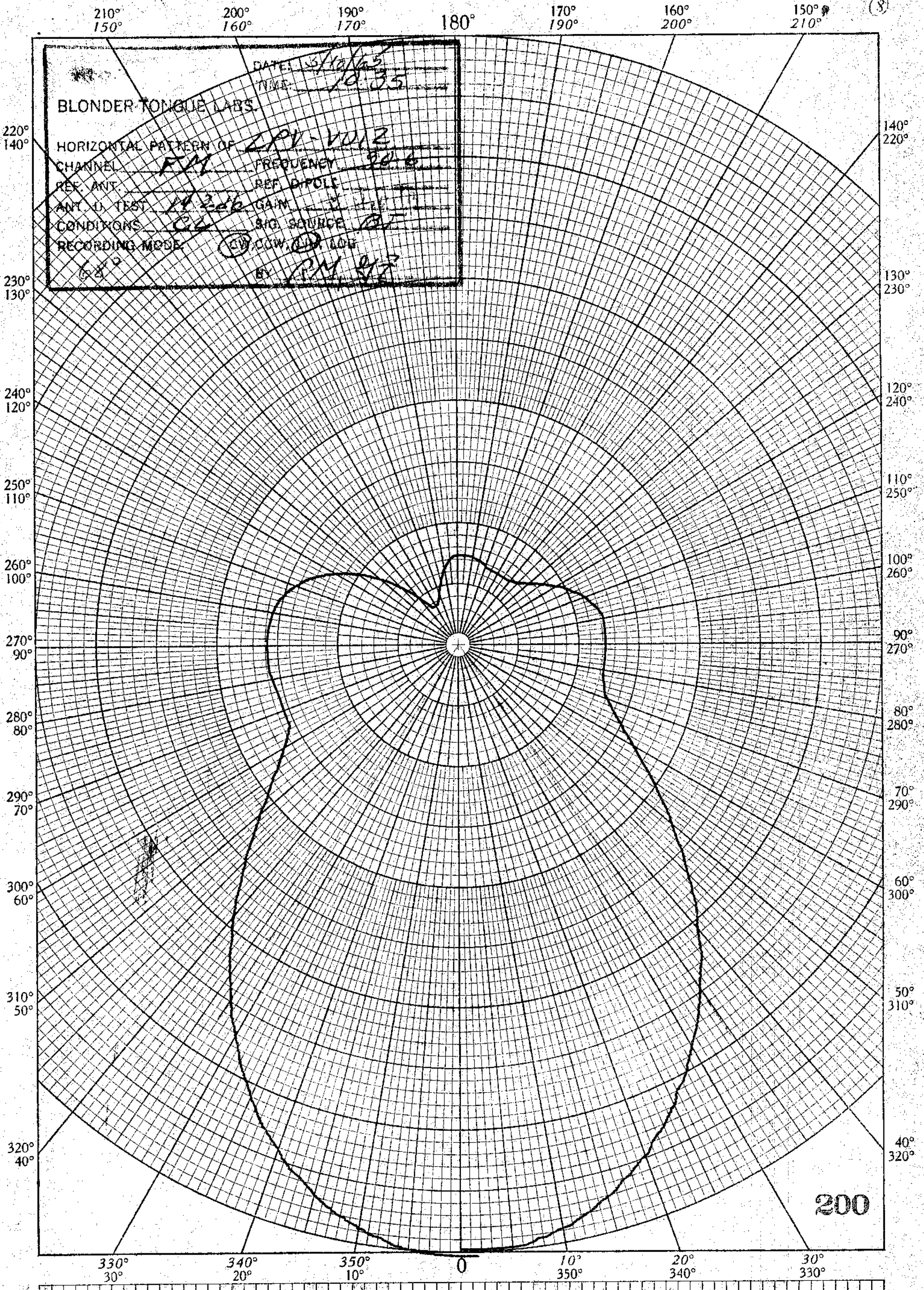


199

(8)

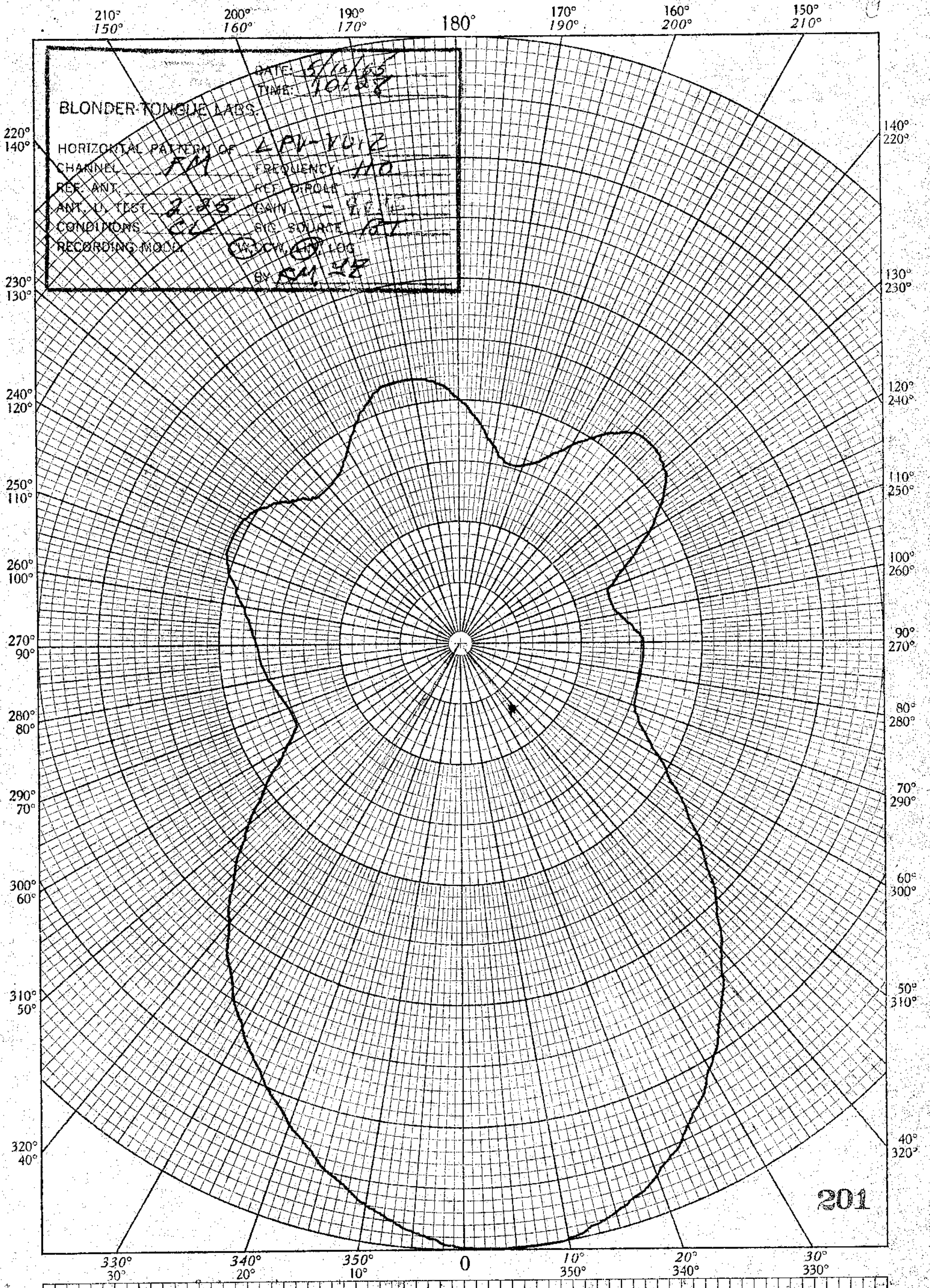
BLONDER-TONGUE LABS.

DATE: 5/16/65
TIME: 10:35
HORIZONTAL PATTERN OF: LPV-VU12
CHANNEL: FM
FREQUENCY: 90.6
REF. ANT.:
REF. DIPOLE:
ANT. U. TEST: 11.2db
GAIN:
CONDITIONS: CL
SIG. SOURCE: BT
RECORDING MODE: [✓ CW], CCW, [✓ LIN], LOG
68°
BY: RM GT



200

K+E POLAR CO-ORDINATE 46 4412 MADE IN U.S.A. KEUFFEL & ESSER CO.



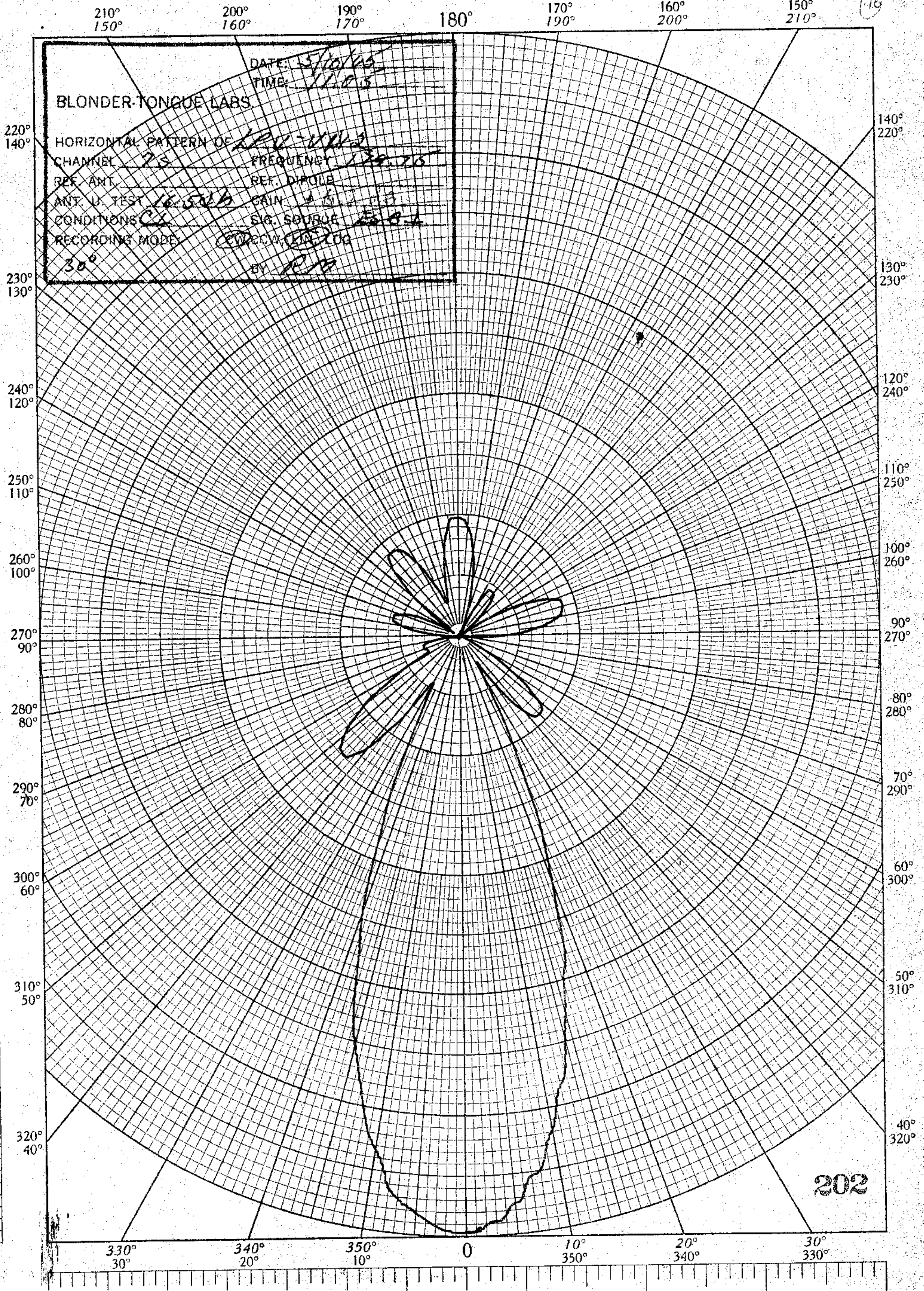
DATE: 5/16/65
TIME: 10:28

BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF LPV-VU12
CHANNEL FM FREQUENCY 110
REF. ANT. REF. DIPOLE
ANT. U. TEST 2-35 GAIN [illegible]
CONDITIONS CL SIG. SOURCE 10Z
RECORDING MODE [✓ CW], CCW, [✓ LIN], LOG
BY RM SZ

201

(16)



BLONDER-TONGUE LABS

DATE: 5/10/65

TIME: 1103

HORIZONTAL PATTERN OF KCU-UW3

CHANNEL 25

FREQUENCY 534.76

REF. ANT.

REF. DIPOLE

ANT. U. TEST 16 SUb

GAIN [illegible]

CONDITIONS CL

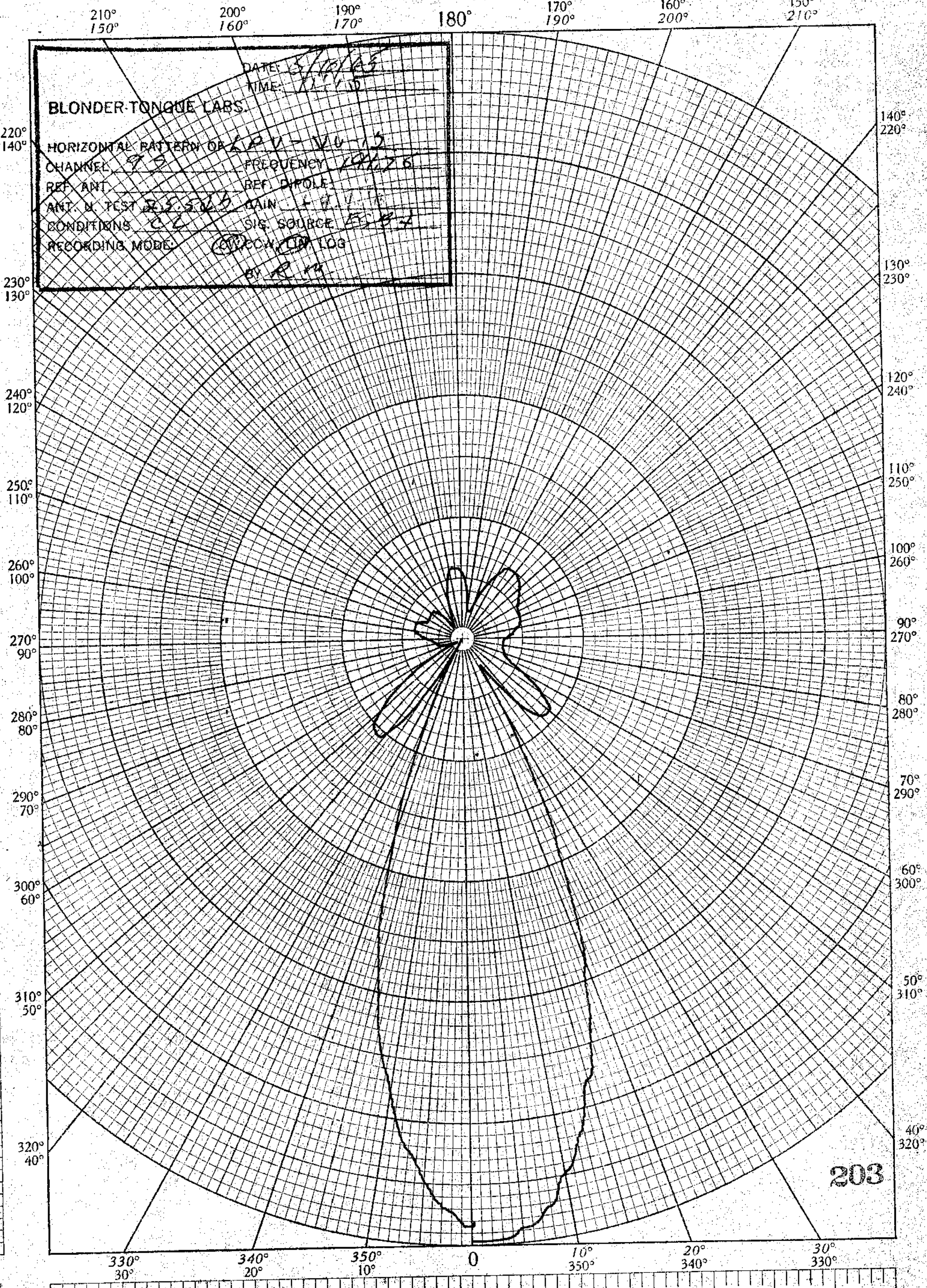
SIG. SOURCE 25 B-1

RECORDING MODE: [✓ CW], CCW, [✓ LIN], LOG

30°

BY R.M.

K&E POLAR CO-ORDINATE 46 4412 MADE IN U.S.A. KEUFFEL & ESSER CO.



DATE: 5/10/65

TIME: 11:10

BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF LPV-VU-12

CHANNEL 9 FREQUENCY 191.76

REF. ANT. REF. DIPOLE

ANT. U. TEST 25.526 GAIN +8.1

CONDITIONS CL SIG. SOURCE [illegible]

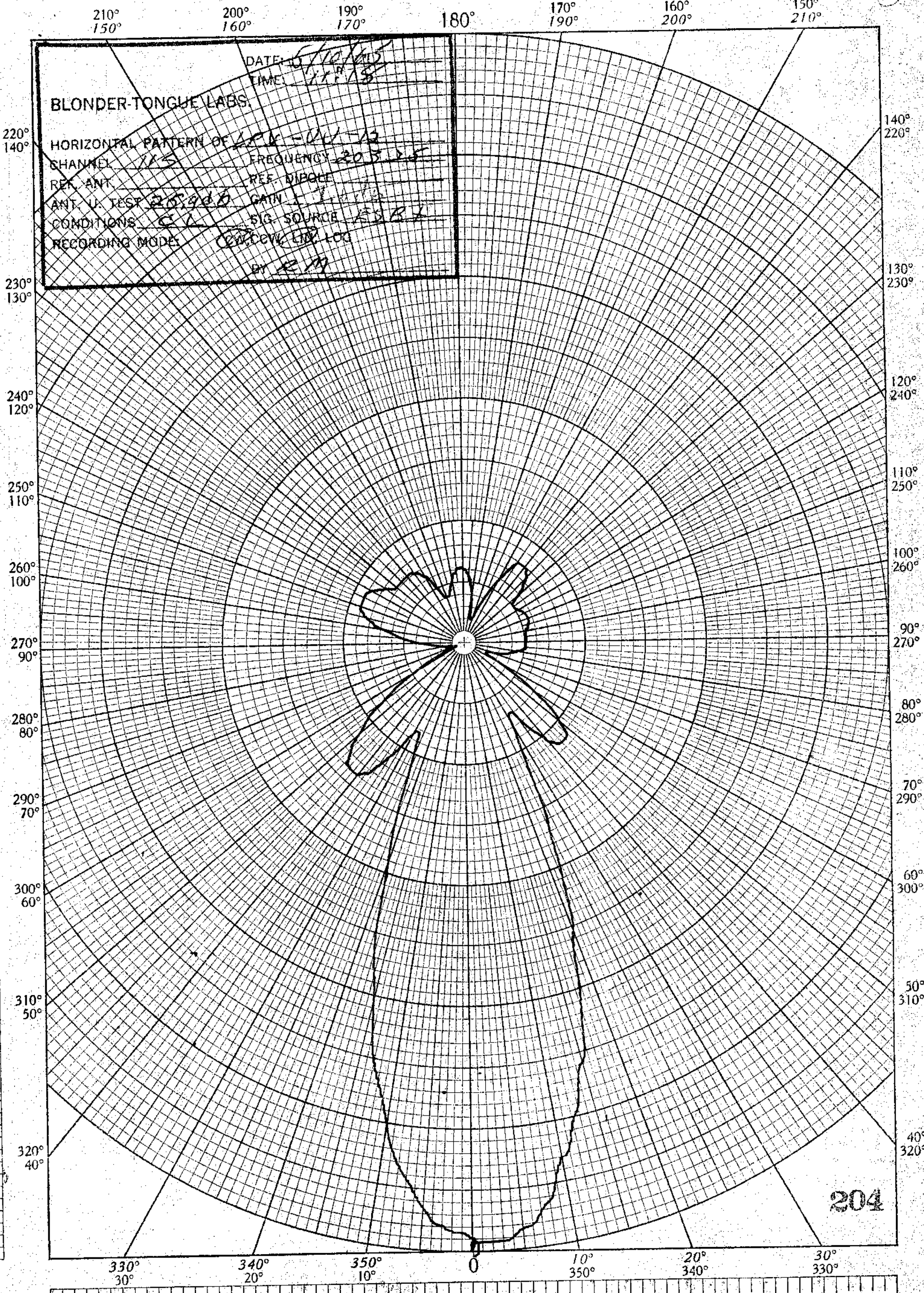
RECORDING MODE: [✓ CW], CCW, [✓ LIN], LOG

BY R.M.

203

K+E POLAR CO-ORDINATE 46 4412 MADE IN U.S.A. KEUFFEL & ESSER CO.

(12)



DATE: 5/10/85

TIME: 11:18

BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF LPV-UH-12

CHANNEL 115 FREQUENCY 203.25

REF. ANT. REF. DIPOLE

ANT. U. TEST 20.9db GAIN [illegible]

CONDITIONS CL SIG. SOURCE ESB1

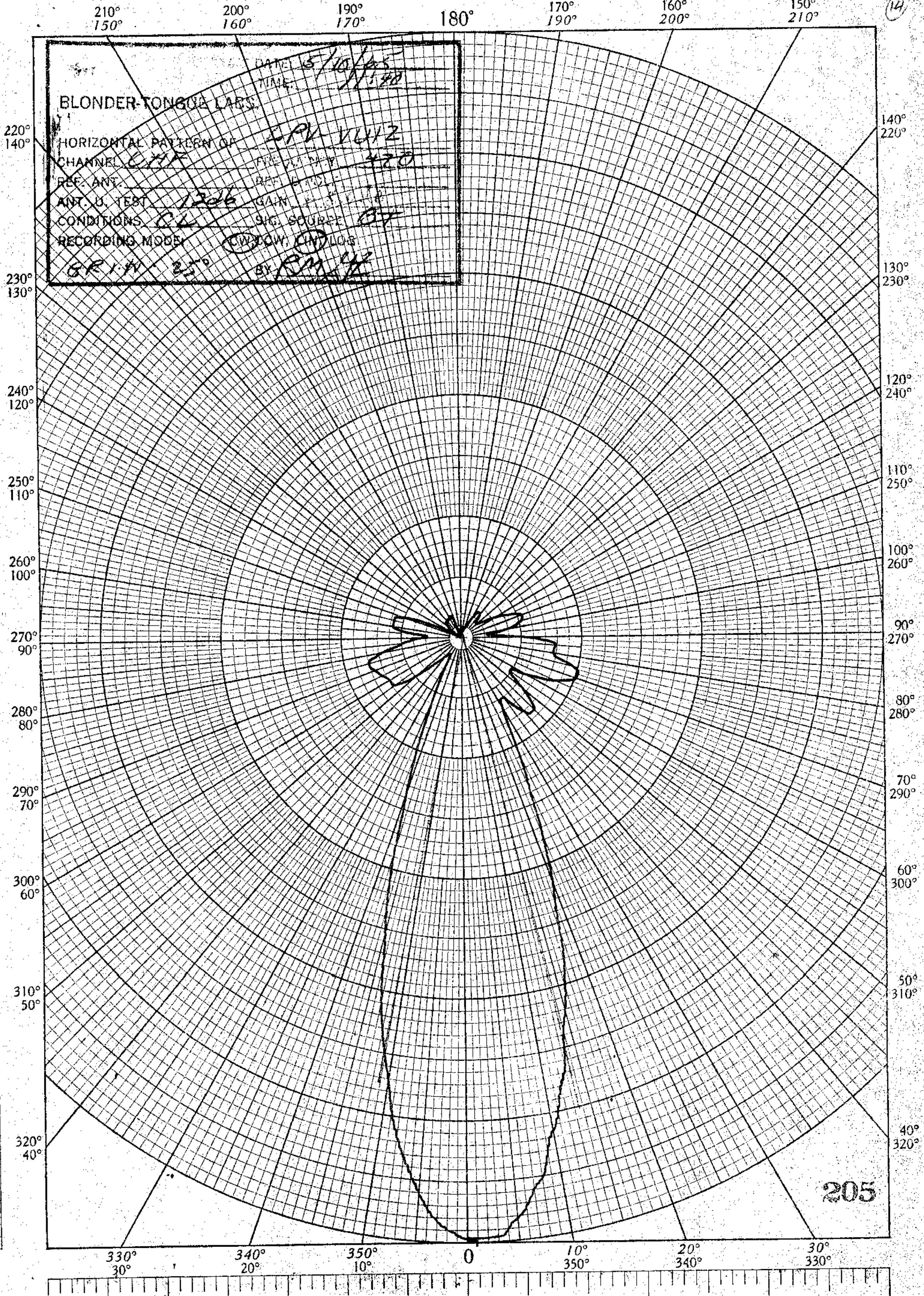
RECORDING MODE: [✓ CW], CCW, [✓ LIN], LOG

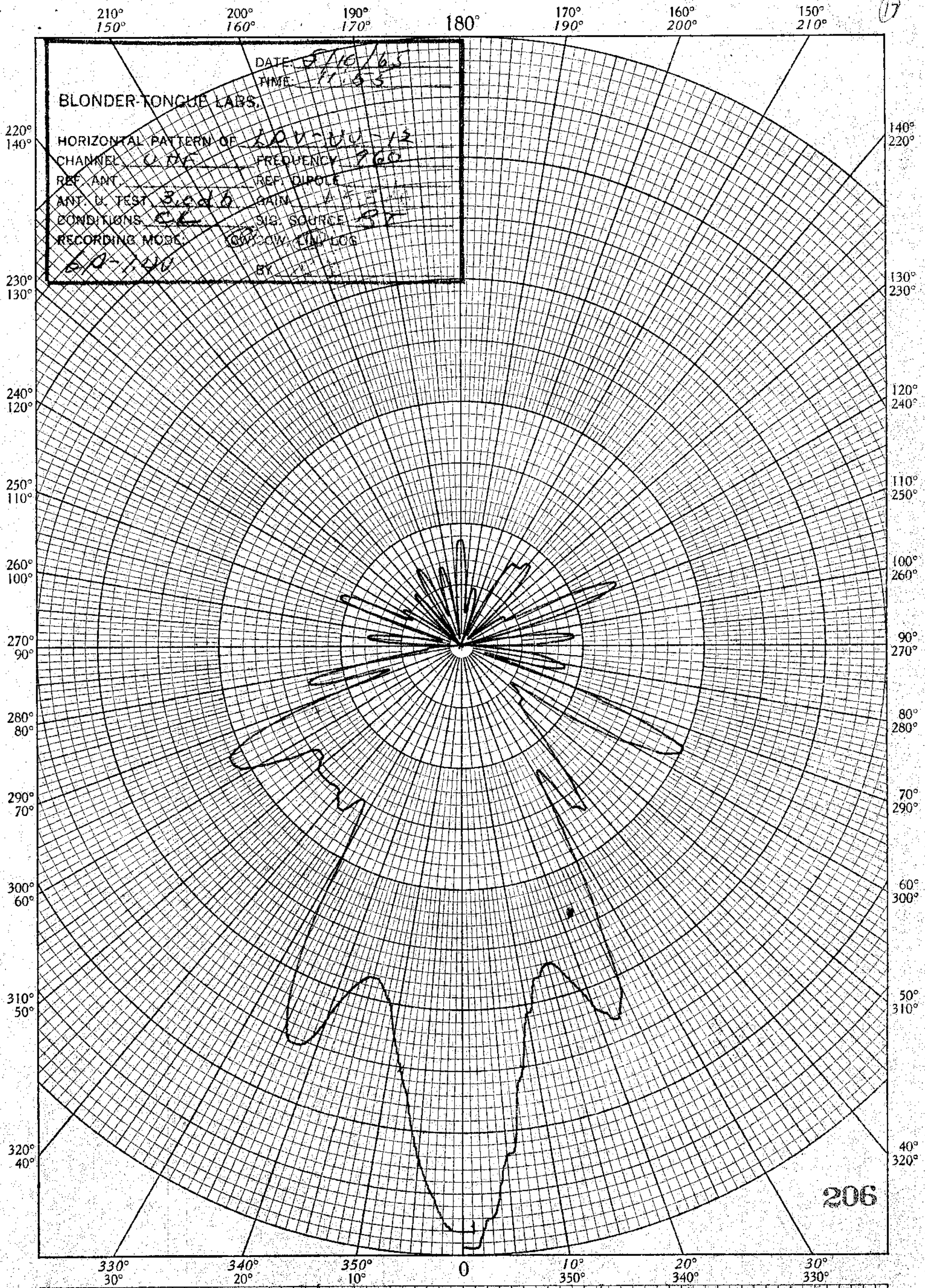
BY RM

(14)

BLONDER-TONGUE LABS.

DATE 5/10/85
TIME 11:40
HORIZONTAL PATTERN OF CPV VU12
CHANNEL CHF
FREQUENCY 420
REF. ANT.
REF. LEVEL
ANT. U. TEST 1206
GAIN
CONDITIONS CL
SIG. SOURCE 07
RECORDING MODE: [✓ CW], CCW, [✓ LIN], LOG
GAIN · 25°
BY RM





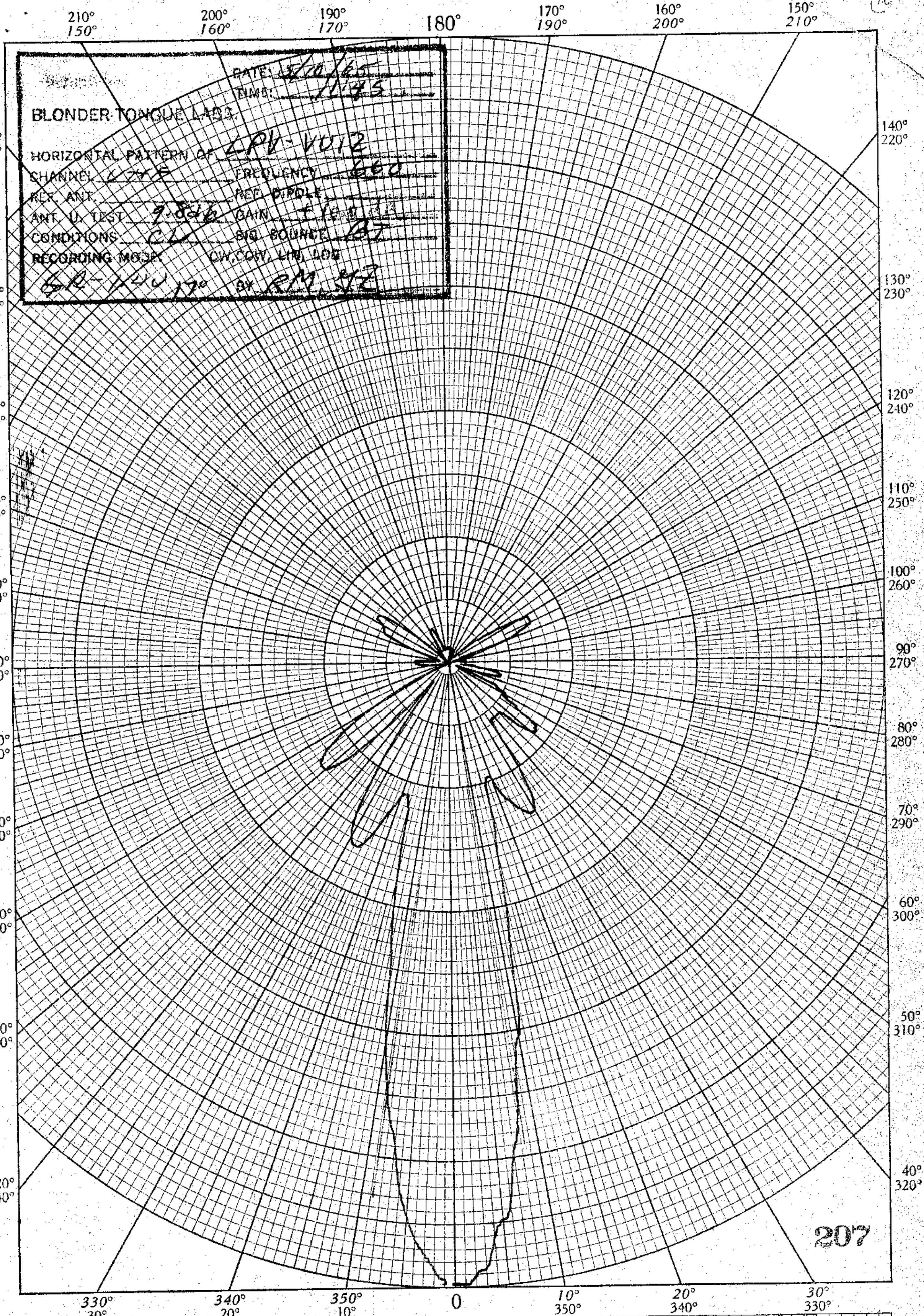
DATE: 8/10/65
TIME: 11:55

BLONDER-TONGUE LABS.

HORIZONTAL PATTERN OF LPV-VU-12
CHANNEL UHF FREQUENCY 760
REF. ANT. REF. DIPOLE
ANT. U. TEST 3,cd b GAIN [illegible]
CONDITIONS CL SIG. SOURCE RT
RECORDING MODE: [✓ SW], CW, [✓ LIN], LOG
LP-14U BY [illegible]

206

(16)



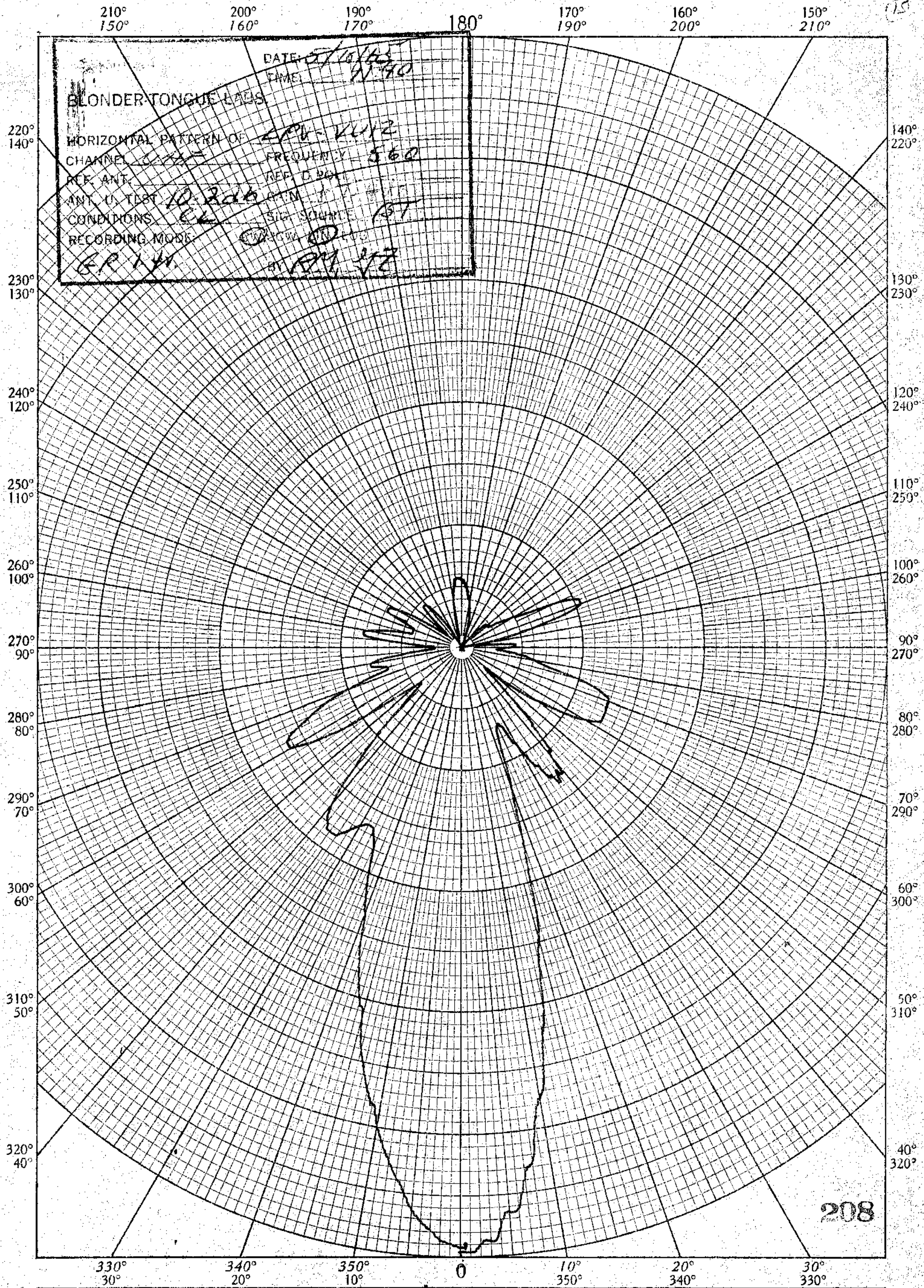
DATE: 3/16/65
TIME: 11:45

BLONDER TONGUE LABS.

HORIZONTAL PATTERN OF LPV-VU12
CHANNEL UHF FREQUENCY 660
REF. ANT. REF. DIPOLE
ANT. U. TEST 9.8db GAIN + [illegible]
CONDITIONS CL SIG. SOURCE BT
RECORDING MODE CW, CCW, LIN, LOG
LR-1/4W 17° BY RM, JZ

207

(13



DATE: 5/16/83

TIME: 11:40

BLONDER-TONGUE LABS

HORIZONTAL PATTERN OF LPV-VU12

CHANNEL C.A.T. FREQUENCY 560

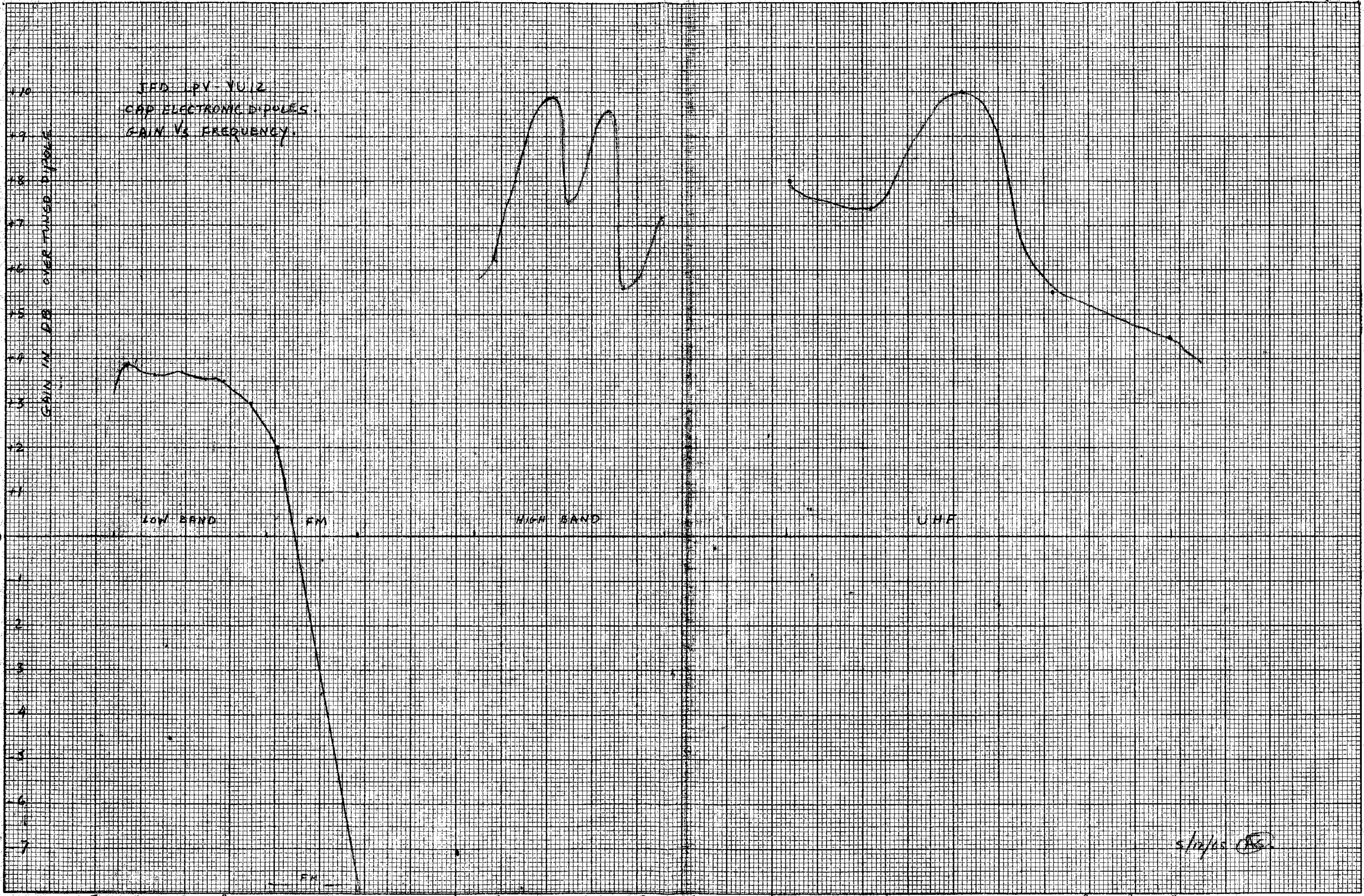
REF. ANT. REF. D POL.

ANT. U. TEST 10-2ab GAIN

CONDITIONS CL SIG. SOURCE BST

RECORDING MODE: [✓ SWR] CW [✓ LIN] LOG

GR 1/4 BY RM 22


JFD LPV-VU12
CAP ELECTRONIC DIPOLES.
GAIN VS FREQUENCY.
GAIN IN DB OVER TUNED DIPOLE
+10
+9
+8
+7
+6
+5
+4
+3
+2
+1
0
-1
-2
-3
-4
-5
-6
-7
LOW BAND
FM
HIGH BAND
UHF
FM
50
60
70
80
90
100
110
170
180
190
200
210
220
450
500
550
600
650
700
750
800
850
900 MC
FREQUENCY IN MC/S

5/12/65 AS

NWR
P Ex 1

Oct. 5, 1965 **D. E. ISBELL** 3,210,767

FREQUENCY INDEPENDENT UNIDIRECTIONAL ANTENNAS

Filed May 3, 1960 2 Sheets-Sheet 1

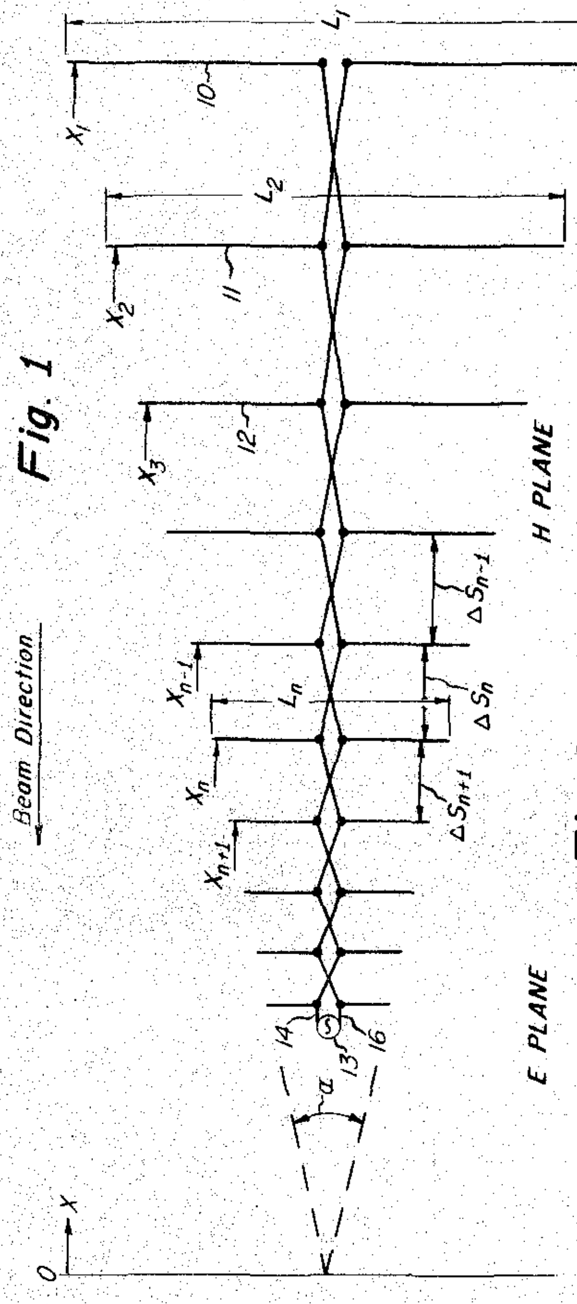


Fig. 1

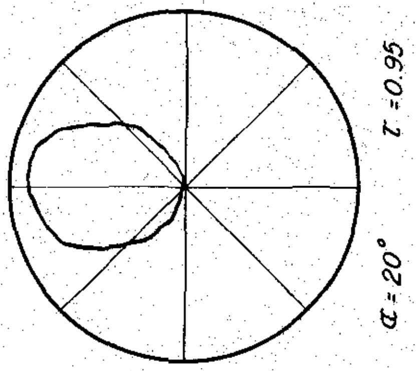


Fig. 4

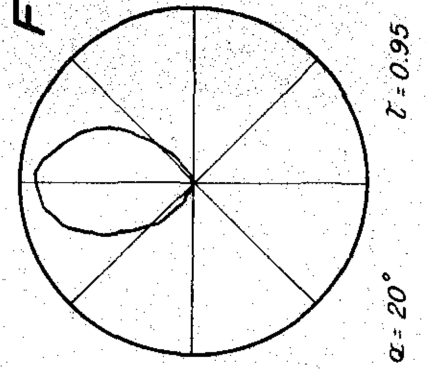


Fig. 3

INVENTOR.
Dwight E. Isbell

BY

Merriam, Smith & Marshall
ATTORNEYS

Oct. 5, 1965

D. E. ISBELL

3,210,767

FREQUENCY INDEPENDENT UNIDIRECTIONAL ANTENNAS

Filed May 3, 1960

2 Sheets-Sheet 2

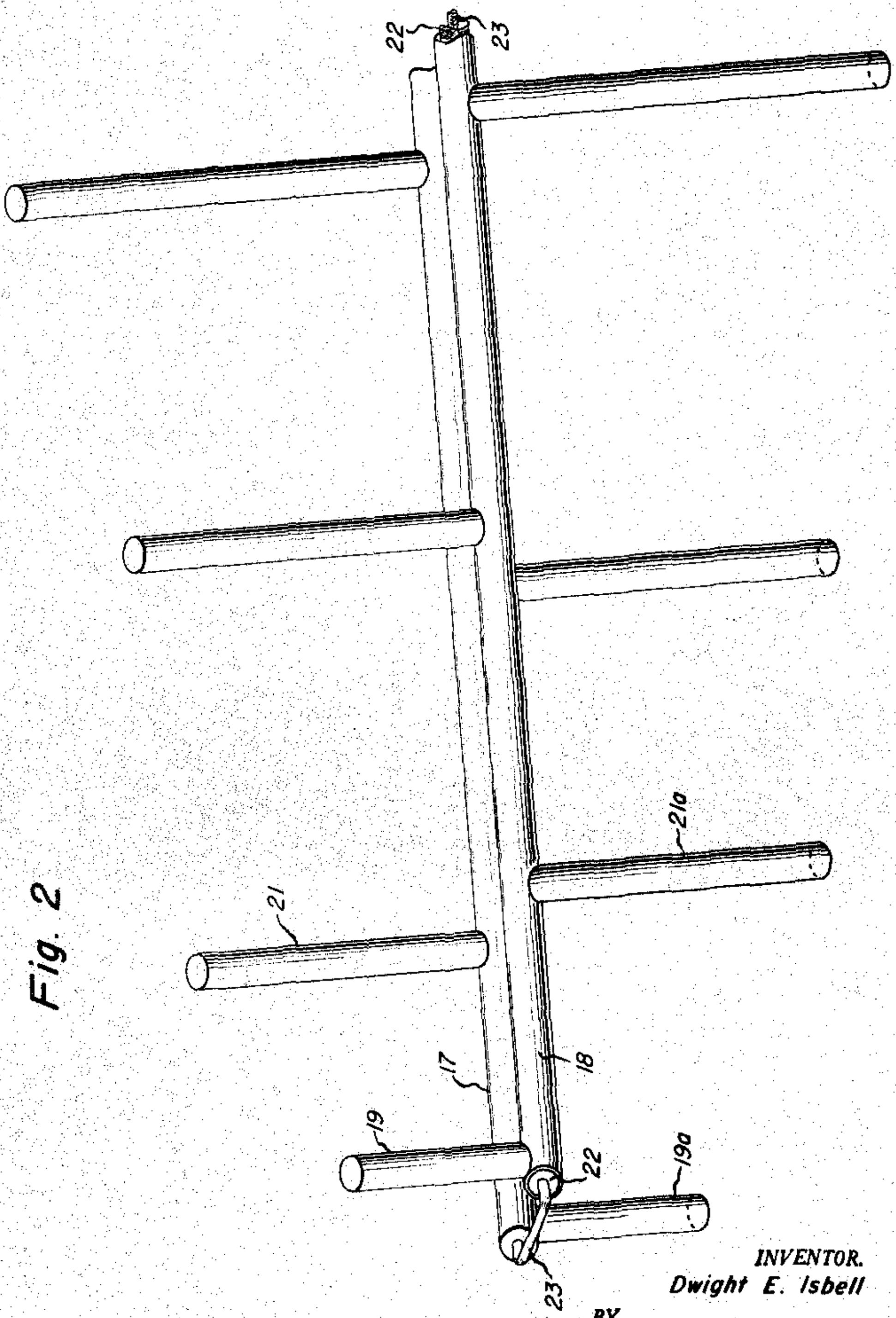


Fig. 2

INVENTOR.
Dwight E. Isbell
BY
Merriam, Smith & Marshall
ATTORNEYS

United States Patent Office

3,210,767
Patented Oct. 5, 1965

3,210,767

FREQUENCY INDEPENDENT UNIDIRECTIONAL ANTENNAS

Dwight E. Isbell, Seattle, Wash., assignor to The University of Illinois Foundation, a non-profit corporation of Illinois

Filed May 3, 1960, Ser. No. 26,589
15 Claims. (Cl. 343—792.5)

This invention relates to antennas, and more particularly, it relates to antennas having unidirectional radiation patterns that are essentially independent of frequency over wide bandwidths.

The antennas of the invention are coplanar dipole arrays consisting of a number of dipoles arranged in side-by-side relationship in a plane, the length and the spacing between successive dipoles varying according to a definite mathematical formula, each of the dipoles being fed by a common feeder which introduces a phase reversal of 180° between connections to successive dipoles. The antennas of the invention provide unidirectional radiation patterns of constant beamwidth and nearly constant input impedances over any desired bandwidth.

The invention will be better understood from the following detailed description thereof taken in conjunction with the accompanying drawing, in which:

FIGURE 1 is a schematic plan view of an antenna made in accordance with the principles of the invention;

FIGURE 2 is an isometric view of a practical antenna embodying the invention; and

FIGURES 3 and 4 are radiation patterns of a typical antenna, in the E plane and H plane, respectively.

Referring to FIGURE 1, it will be seen that the antenna of the invention was composed of a plurality of dipoles **10**, **11**, **12**, etc., which are coplanar and in parallel, side-by-side relationship. It will be noted that the lengths of the successive dipoles and the spacing between these dipoles is such that the ends of the dipoles fall on a pair of straight lines which intersect and form an angle α. In the preferred embodiment the antenna is symmetrical about a line passing through the midpoints of the dipoles, as shown.

[illegible] The antenna is fed at its narrow end from a conventional source of energy, depicted in FIGURE 1 by alternator **13**, by means of a balanced feeder line consisting of conductors **14** and **16**. It will be seen that the feeder lines **14** and **16** are alternated between connections to consecutive dipoles, thereby producing a phase reversal between such connections.

The lengths of the dipoles and the spacing between dipoles are related by a constant scale factor τ defined by the following equations:

$$\tau=\frac{L_{(n+1)}}{L_n}=\frac{\Delta S_{(n+1)}}{\Delta S_n}$$

where τ is a constant having a value less than 1, L_n is the length of any intermediate dipole in the array, $L_{(n+1)}$ is the length of the adjacent smaller dipole, ΔS_n is the spacing between the dipole having the length L_n and the adjacent larger dipole, and $\Delta S_{(n+1)}$ is the spacing between the dipole having the length L_n and the adjacent smaller dipole.

It will be seen from the geometry of the antennas, as given above, that the distance from the base line 0 at the vertex of the angle α to the dipoles forming the array are defined by the equation:

$$\tau=\frac{X_{(n+1)}}{X_n}$$

where X_n is the distance from the base line 0 to the dipole having the length L_n, $X_{(n+1)}$ is the corresponding distance from the base line to the adjacent smaller dipole, and τ has the significance previously given.

The radiation pattern of the antennas of the invention, having the geometrical relationship among the several parts as defined above, is unidirectional in the negative X direction, i.e., extending to the left from the narrow end of the antenna of FIGURE 1.

The construction of an actual antenna made in accordance with the invention is shown in FIGURE 2. In this antenna the balanced line consists of two closely-spaced and parallel electrically conducting small diameter tubes **17** and **18** to which are attached the dipoles, each of which consists of two individual dipole elements, e.g., **19** and **19***a*, **21** and **21***a*, etc. It will be noted that each of the two elements making up one dipole is connected to a different one of said conductors **17** and **18**, in a direction perpendicular to the plane determined by said conductors **17** and **18**. Moreover, considering either one of the conductors **17** and **18**, consecutive dipole elements along the length thereof extend in opposite directions. It will be seen that this construction has the effect of alternating the phase of the connection between successive dipoles, as depicted schematically in FIGURE 1. Although the dipoles of FIGURE 2 are not precisely coplanar, differing therefrom by the distance between the parallel conductors, in practice this distance is very small so that the dipole elements are substantially coplanar and the advantages of the invention are maintained. The antenna of FIGURE 2 may be conveniently fed by means of a coaxial cable **22** positioned within conductor **18**, the central conductor **23** thereof extending to and making electrical connection with conductor **17** as shown.

As an example of the invention, an antenna of the type shown in FIGURE 2 was constructed using 0.125 inch diameter tubing for the balanced line and 0.050 inch diameter wire for the elements. The elements were attached to the feeder line with soft solder, and the array was fed with miniature coaxial cable inserted through one of the balanced line conductors. The antenna was defined by the parameters $\tau=0.95$ and $\alpha=20°$. The antenna had a total of 15 dipoles, with the longest dipole element being 2½" long, while the shortest element was one-half of this length, or 1¼". The array was 7½" long.

Typical radiation patterns for the above-described antenna in the E plane and the H plane are shown in FIGURES 3 and 4, respectively. These patterns were found to remain essentially constant over the band of about 1100 to 1800 mc./sec. The minimum front-to-back ratio over this band was 17 db and the directivity over the range from about 1130 to 1750 mc./sec. was better than 9 db over isotropic. non-TV

The performance of the above-described antenna clearly indicates that the antennas of the invention provide excellent rotatable beams for use particularly in the HF to UHF spectrum. In comparison to the well-known parasitic types of antennas which bear some resemblance to those of the invention, such as the Yagi array, the antennas of the invention provide a much wider bandwidth with essentially comparable directivity. Advantageously, however, the antennas of the invention need no adjusting for their performance over a wide bandwidth, compared to the parasitic types which must be adjusted by cut-and-try procedures for each frequency. Further experimental work with other antennas similar to that described above has indicated that the preferred values for the parameters which define the antennas of the invention include a range of values for angle α between about 20° and 100°, with τ having a value between about 0.8 and about 0.95. When these parameters have values within the preferred ranges the antennas were found to have essentially frequency independent performance over any desired bandwidth. The upper and lower limits of the bandwidths may be adjusted as desired by fixing the lengths of the longest dipole and the shortest dipole, respectively. It has been determined experimentally that the longest dipole element should be approximately 0.47 wavelength long at the lower limit and the shortest element should be about 0.38 wavelength long at the upper limit. Moreover, in order to provide a suitable front-to-back ratio at the low frequency limit, there should be at least 3 dipoles in the array and preferably about 10 to 30 dipoles.

The foregoing detailed description has been given for clearness of understanding only, and no unnecessary limitations should be understood therefrom, as modifications will be obvious to those skilled in the art.

What is claimed is:

1. A broadband unidirectional antenna comprising an array of substantially coplanar and parallel dipoles of progressively increasing length and spacing in side-by-side relationship, the ratio of the lengths of any two adjacent dipoles being given by the formula

$$\frac{L_{(n+1)}}{L_n}=\tau$$

where L_n is the length of any intermediate dipole in the array, $L_{(n+1)}$ is the length of the adjacent smaller dipole and τ is a constant having a value less than 1, the spacing between said dipoles being given by the formula

$$\frac{\Delta S_{(n+1)}}{\Delta S_n}=\tau$$

where ΔS_n is the spacing between the dipole having the length L_n and the adjacent larger dipole, $\Delta S_{(n+1)}$ is the spacing between the dipole having the length L_n and the adjacent smaller dipole, and τ has the significance previously assigned, said dipoles being fed in series by a common feeder which alternates in phase between successive dipoles.

2. The array of claim **1** which is symmetrical about a line passing through the midpoint of each dipole in the array.

3. A broadband unidirectional antenna comprising an array of a plurality of substantially coplanar and parallel dipoles of progressively increasing length in side-by-side relationship, the ends of said dipoles falling on a V-shaped line forming an angle α at its vertex, the ratio of the lengths of any pair of adjacent dipoles being given by the formula

$$\frac{L_{(n+1)}}{L_n}=\tau$$

where L_n is the length of the longer dipole of the pair, $L_{(n+1)}$ is the length of the shorter dipole, and τ is a constant having a value less than 1, the dipoles in said array being fed in series by a common feeder which alternates 180° in phase between successive dipoles.

4. The antenna of claim **3** in which the angle α has a value between about 20° and 100° and the constant τ has a value between about 0.8 and 0.95.

5. The antenna of claim **3** in which said feeder is a balanced line which twists 180° between the connections to successive dipoles.

6. A broadband unidirectional antenna comprising a balanced feeder line consisting of two closely spaced, straight and parallel conductors, a plurality of dipoles each consisting of two dipole elements, one of which elements is connected to one of said conductors, the other element being connected directly opposite the first to the other of said conductors, the elements of any dipole extending in opposite directions perpendicular to the plane determined by said conductors, consecutive dipole elements on each of said conductors extending in opposite directions, the ratio of the lengths of the elements in any two adjacent dipoles being given by the formula

(co-planar)

$$\frac{l_{(n+1)}}{l_n}=\tau$$

where l_n is the length of an element of any dipole in the antenna, $l_{(n+1)}$ is the length of an element in the adjacent smaller dipole and τ is a constant having a value less than l, the spacing between said dipoles being given by the formula

$$\frac{\Delta S_{(n+1)}}{\Delta S_n}=\tau$$

where ΔS_n is the spacing between the dipole having the element length l_n and the adjacent larger dipole, $\Delta S_{(n+1)}$ is the spacing between the dipole having the element length l_n and the adjacent smaller dipole, and τ has the significance previously assigned.

7. The antenna of claim **6** wherein τ has a value of about 0.8 to 0.95.

8. The antenna of claim **6** wherein said feeder line conductors are tubular.

9. An aerial system including at least one set of parallel dipoles spaced along and substantially perpendicular to the longitudinal axis of a two-conductor balanced feeder to which the halves of the dipoles are connected at their inner ends, said dipoles being of different electrical lengths increasing substantially logarithmically from the connected end of the feeder to the other end and the dipole feeder connections being crossed over one another between adjacent dipoles, the spacings between which also increase substantially logarithmically from said connected end to the other end.

10. An antenna system for wide-band use comprising a plurality of substantially parallel conducting dipole elements arranged in substantially collinear pairs, the opposite dipole elements of each pair constituting dipole halves, a two-conductor balanced feeder having one conductor connected to each of said elements at substantially the inner end thereof, each of said dipole halves in a pair being connected to a different feeder conductor, adjacent dipole elements being reversely connected to different conductors of the feeder, said dipole elements being selectively spaced along and substantially perpendicular to said feeder, the elements of each pair being of substantially equal length, adjacent dipole elements of different pairs differing in length with respect to each other by a substantially constant scale factor, the selective spacings between adjacent dipoles generally decreasing from one end of the feeder to the other with the greatest spacing being between the longest dipoles, and means to connect the feeder to an external circuit at substantially the location of the smallest of the dipole elements.

11. An antenna system for wide-band use comprising a plurality of substantially parallel conducting dipole elements arranged in substantially collinear pairs, the opposite dipole elements of each pair constituting dipole halves, a two-conductor balanced feeder having one conductor connected to each of said elements at substantially the inner end thereof, each of said dipole halves in a pair being connected to a different feeder conductor, adjacent dipole elements being reversely connected to different conductors of the feeder, said dipole elements being selectively spaced along and substantially perpendicular to said feeder, the elements of each pair being of substantially equal length, adjacent dipole elements of different pairs differing in length with respect to each other by a substantially constant scale factor, the selective spacings between the dipoles along the feeder differing from each other also by a substantially constant scale factor, the greatest spacing being between the longest dipoles, and means to connect the feeder to an external circuit at substantially the location of the smallest of the dipoles.

12. The aerial system of claim **11** in which said scale

factors have values within the range from about 0.8 to about 0.95.

13. An antenna system for wide-band use comprising an array of at least three linear substantially parallel conducting dipoles, each dipole being composed of two opposite substantially collinear conducting elements, a two-conductor balanced feeder having one conductor connected to each of said elements at substantially the inner end thereof, adjacent parallel dipole elements being reversely connected to a different conductor of the feeder, the two elements of each dipole being of substantially equal length and successive elements being of lengths which differ from one dipole to the next by a substantially constant scale factor within the range from about 0.8 to about 0.95, the dipoles being spaced from each other in a generally decreasing manner in the direction of decreasing element length, and means to connect the feeder conductors to an external circuit at substantially the location of the smallest dipole elements.

14. An antenna system for wide-band use comprising a minimum of three pairs of linear substantially parallel conducting elements arranged substantially coplanarly, each pair being substantially collinear and comprising the halves of a dipole, a two-conductor feeder connected to the inner ends of said collinear pairs of elements, adjacent parallel elements being connected to different conductors of the feeder so that the halves of the dipoles connect to different conductors of the feeder and adjacent dipoles are reversely connected, the halves of each dipole being substantially the same length, adjacent dipole elements being selectively spaced from each other along the feeder, the length of the successive dipole elements along the feeder decreasing in accordance with a substantially constant scale factor, each dipole and the feeder between it and the adjacent dipole constituting a cell, the dimension of the several cells measured from the point of connection of one dipole and the feeder to the outer end of the next smaller adjacent dipole also decreasing from one cell to the next in the direction of decreasing dipole length according to a substantially constant scale factor so that the combination of cells provides a substantially uniform wide-band response, and means to connect an external circuit to the feeder elements at substantially the location of the shortest of the dipoles.

15. An antenna system for wide-band use comprising a minimum of three pairs of substantially parallel and coplanar linear conducting elements arranged in substantially collinear pairs, each pair of elements comprising the halves of a dipole, a two-conductor feeder, one conductor of which is connected to each of said elements substantially at the inner end thereof, adjacent parallel elements being connected to different conductors of the feeder so that the halves of the dipoles connect to different conductors of the feeder and adjacent dipoles are reversely connected, the halves of each dipole being substantially the same length, adjacent dipole elements being selectively spaced from each other along the feeder, the lengths of the elements decreasing from one end of the feeder to the other substantially in accordance with a substantially constant scale factor within the range from about 0.8 to 0.95, each dipole and the feeder between it and the adjacent dipole constituting a cell, the cell dimension from the inner end of one dipole to the outer end of the next smaller adjacent dipole also generally decreasing from one cell to the next in the direction from the longer to the shorter dipoles so that the combination of cells provides a substantially uniform wide-band response, and means to connect an external circuit to the feeder elements at substantially the location of the shortest of the dipoles.

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2,507,225	5/50	Scheldorf	343—814 X

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408,473	4/34	Great Britain.

HERMAN KARL SAALBACH, *Primary Examiner.*

GEORGE N. WESTBY, ELI LIEBERMAN, *Examiners.*

Configuration ^Davis^ same as Fig. 2

Prior art -- mostly prior & Isbell

combin of structural components

JH learned of combin. - ? 1959-60

~~Prior~~ Did he know all prior art then

(#) (#) Duhamel xore then.

Isbell discover it?

(#) (e) Isbell discover

~~establish~~ prior art.

(take ^word^ "deflector" -- claims read on Duhamel)

JH learned of Meyers combin = 1959-60

Prior -

Draw wide - transform

coplanar

essentially in same plane

deviations allowable

Isbell not only with TV?

Any diff test than before
such in measurements?

When 1st see B-T ant.?

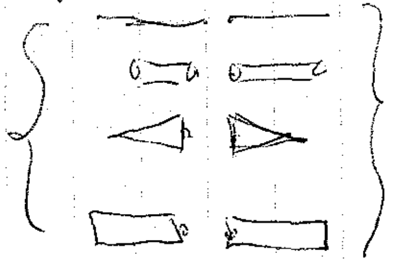
✓ When decide to test

How know original?

Among el March — checked
pair as spaced
plane by pen.
P.O. concluded a
diff atty than
Isbell?

show
~~[illegible]~~
when is lately
made Isbell [illegible]

[illegible] known configuration
of dipoles



all dipoles -- all work
similarly, tho' diff impedances.

On DT antenna --
any a priori way know
whether work as by pen spaced
planes?

1.

Barron - Holtz Fed Pract. & Procedure

§ 2575 — A motion for a continuance of the trial is addressed to the sound judicial discret. of the Ct. & its denial is ordinarily no ground for reversal. A refusal of a continuance to afford adequate time for defense witnesses to attend may be reversible error. 160 F2d 8

Cyclopedia of Fed. Procedure

The granting of a continuance generally rests in the ct's discretion, which is reviewable only for abuse.

Compton v U.S. 334 F2d 212 (continuance to permit change of counsel)
(refusal not abuse of discretion)

236 F2d 447 - (refusal within ct's discretion

A stay of proceedings, likewise, is within discretion of trial cts. in their exercise of this discretion, save that care must be taken, under the circumstances of each case, that injustice is not done either by precipitate trial or wanton delay.

There is no gen. rule for guidance

Nichols v Republic 89 F2d 927 — and in ruling on an application for continuance, the cts may properly consider whether the moving party has, prior to the instant motion, occasioned material delay in bringing the case to trial & whether the granting of a continuance will necessitate undue delay. 22 F2d 59

Continuance proper in case of sudden illness of a juror, epidemic in community where Δ reside & consequ. inability to prepare a defense — death of a party's sole counsel, or the incapacitating illness of his principal atty in charge of the case are fair grounds for continuance.

The absence of a material witness may in proper circumstances be suffic. ground for a reasonable continuance, even tho the deposition of such witness could be taken. 61 F2d 124 (Darrow v US)

Unavoidable absence of a party, who may also be a witness, does not make it obligatory on trial judge to grant a continuance on that ground. 149 F Supp 57 (Skinner)

A continuance may not properly be denied to a pl. who is also a principal witness, is prevented by illness from attending Ct. on day of trial, & shows a substantial likelihood of being able to attend Court & testify within a reasonable time, if the delay will cause no injury to Δ.

Refusal of a continuance because of the absence of a material witness is not an abuse of discretion, however, if the whereabouts of such witness are unknown or it is not shown that his attendance at a later time could be procured, or if it does not appear that an effort has been made to secure the absent witness, or take his deposition, or if his testimony would not change the result, or if materiality of the absent witnesses' testimony is not shown.

see Royster v Lederle 128 F2d 197

A party to an action should not be compelled to go to trial in his absence or in the absence of the only witness by whose testimony he can make out his defense, unless it appears that he has been guilty of neglig in failing to attend the trial or procuring the attendance of the witness on whom he relies or in obtaining his testimony by deposition or otherwise.

Where motion to continue is based upon absence of a material witness, the showing should include some legal explanation for his absence. 267 F 145 D under - also show he can be produced during time of continuance. - also show what his testimony would be if present, that it is admissible, relevant & competent - that it will tend to support moving party's case & that such witness' personal presence is either indis or necess.

Denial of motion for continuance is not final decision from which appeal will lie. 327 F2d 697

Absence of witness 149 F2d 84. - denied

Hoabach 143 F2d 594 allowed

p116

claim — unexplained
reasons [illegible] technically —
should [illegible] determine
not in terms
to give
facts
[illegible]
[illegible]
[illegible]

Functions in same manner

~~[illegible] same~~ body

to give same result — —

on what basis — —

pure assertion — —

no facts — no tests —

nothing —

burden of proof on infringer -- H~~[illegible]~~

UNION LEAGUE CLUB OF CHICAGO
65 WEST JACKSON BOULEVARD
CHICAGO 4, ILLINOIS

1. Hasn't said a single claim is infringed or what claim.

2. Hasn't shown that all the technical elements of any claim are all in the accused structure
(Ward exhibits do this, rather)

3. Has only referred to

p 94 : Same structural components as those claimed by patents

p. 112 5

p 116

⊕ Not even testimony that all structural components of the claims are in the accused re infringement

Carl Hansen
1920
265 F 902

155 F2d 746
-749

March 5, 1940. M. KATZIN 2,192,532

DIRECTIVE ANTENNA

Filed Feb. 3, 1936

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
BEFORE JUDGE HOFFMAN
DEFENDANT EX. NO. J
DOROTHY L. BRACKENBURY
OFFICIAL COURT REPORTER

Fig. 1

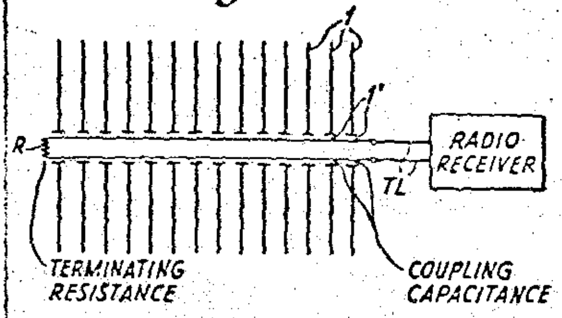


Fig. 2

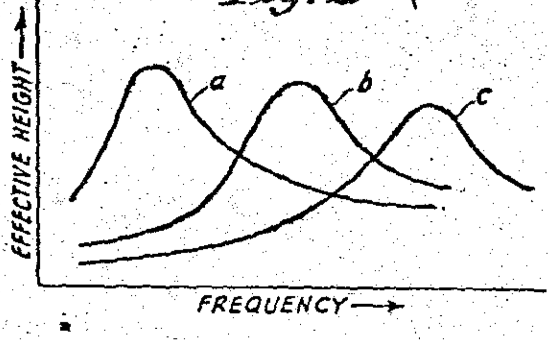


Fig. 3a

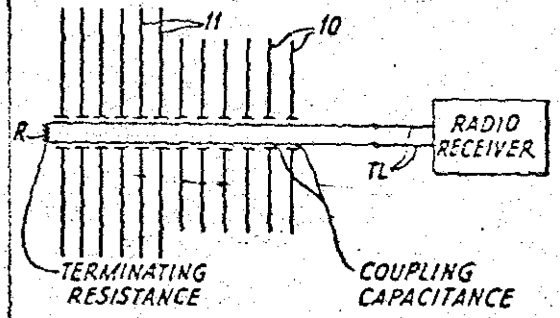


Fig. 3b

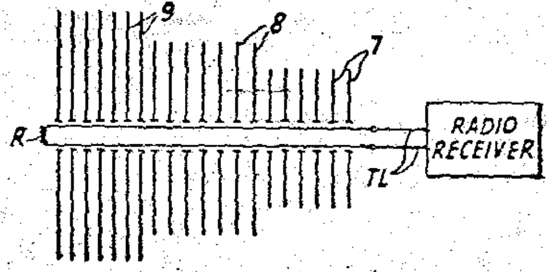


Fig. 3c

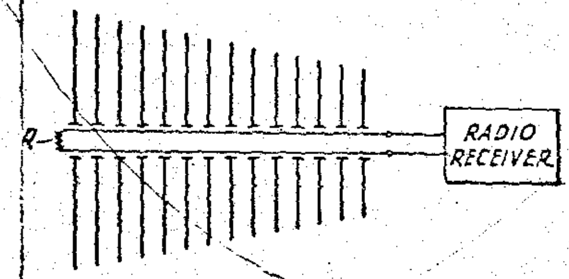


Fig. 4

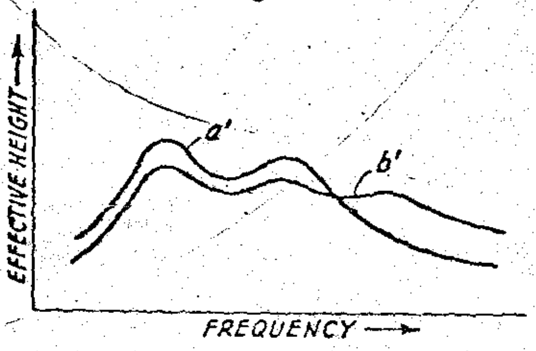
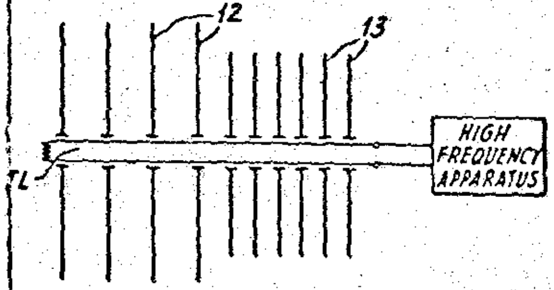


Fig. 3d



INVENTOR.
MARTIN KATZIN

BY H. S. Grover

ATTORNEY.

Patented Mar. 5, 1940 2,192,532

UNITED STATES PATENT OFFICE

2,192,532

DIRECTIVE ANTENNA

Martin Katzin, Riverhead, N. Y., assignor to Radio Corporation of America, a corporation of Delaware

Application February 3, 1936, Serial No. 62,014

11 Claims. (Cl. 250—33)

This invention relates to directive antennas and more particularly to directive receiving antennas of the so-called "fishbone" array.

The directive "fishbone" receiving array now used in commercial radio reception consists of a number of parallel, equally spaced, similar size collector wires or doublets connected through small coupling capacitors to a common transmission line which conducts the signal to the radio receiver. The length of the collector wires and the size of the coupling condensers are chosen to give maximum received signal for a desired band of frequencies. Such an arrangement is described in U. S. Patent No. 1,821,402, granted September 1, 1931, to Harold O. Peterson. It has been found, however, that this antenna array responds rather markedly to only a relatively small frequency band, so that it is necessary to use several arrays to effectively cover the commercial frequency spectrum.

The present invention provides an improved directive antenna in the form of a "fishbone" array which gives more uniform response over a wide frequency band and thus makes it possible to efficiently receive over a much wider frequency spectrum, so that for a given frequency range to be covered, a smaller number of antenna arrays will be required.

A better understanding of the present invention may be had by referring to the following detailed description which is accompanied by drawing wherein:

Fig. 1 illustrates a known type of antenna in the form of a so-called "fishbone" array;

Fig. 2 is a graph showing curves explanatory of the operation of Fig. 1;

Figs. 3*a*, 3*b*, 3*c* and 3*d* illustrate four different embodiments of the present invention; and

Fig. 4 is a graph showing curves explanatory of the operation of the antennas of the invention.

Referring to Fig. 1, there is shown a directive antenna of known type comprising a two wire transmission line TL to which are coupled transverse doublets 1. The wires of transmission line TL are closely spaced in order to avoid their picking up received energy. One terminal of the transmission line is connected to suitable high frequency apparatus, herein indicated conventionally in box form by the designation "radio receiver." To make the antenna unilateral in directivity, the end of the line TL nearest the desired transmitting station and farthest removed from the radio receiver is closed by a suitable terminating resistance R whose impedance is equal to the surge impedance of the line as loaded by energy collecting doublets 1. Resistance R absorbs energy approaching from the direction of the radio receiver and thereby prevents its reflection back to the receiver.

The energy collecting doublets 1 are preferably untuned and coupled externally to the feeder members through limiting impedances, herein shown preferably in the form of small series condensers 1'. United States Patent No. 1,908,536 describes a type of coupling condenser commonly used in this type of antenna. By loosely coupling the doublets to the transmission line TL in this manner, they have less effect upon the velocity of the wave in the line, and their effect remains small in spite of appreciably large variations in the length of the received waves. Since this type of antenna is well-known in the art, no further description is herein deemed necessary, except perhaps to refer to United States Patent No. 1,821,402, supra, which describes such an arrangement.

Fig. 2 shows various graphs illustrating frequency versus effective height characteristics of an antenna of the type shown in Fig. 1. Graph *a* is the frequency response curve for a "fishbone" antenna having one particular length of doublet wire and value of coupling condenser. Graph *b* shows a similar frequency response curve for a shorter length of doublet, and graph *c* represents a frequency response curve for a still shorter length of doublet.

Referring to Fig. 3*a* which illustrates one embodiment of the present invention, there are shown two sets of doublets 10 and 11 having different lengths, all capacity coupled to the line TL in the same manner as shown in Fig. 1. The doublets 10 and 11, it will be observed, are grouped together in two different lengths.

Fig. 3*b* shows another embodiment of the invention which is quite similar to the system of Fig. 3*a* except that there are here shown a "fishbone" array having groups of doublets of three different lengths, namely 7, 8 and 9. In this embodiment doublets 9 contribute the greater portion of the energy at the lower frequencies, doublets 8 at intermediate frequencies and doublets 7 at the higher frequencies. Now, at the higher frequencies where doublets 7 are contributing the greater portion of the signal energy doublets 9 may load the transmission line TL quite heavily. Therefore, it is advantageous to place these doublets ahead of doublet 7 so that the useful signal energy passing from 7 to the transmission line and thence to the receiver is not absorbed by the loading of doublets 9.

Fig. 3c illustrates a still further embodiment of the invention wherein there is employed a tapered array comprising doublets which taper continuously in length from one end of the antenna to the other.

In Fig. 3d, which illustrates a further embodiment, the spacings between adjacent doublets along the transmission line TL are made greater for the longer doublets 12 than for the shorter ones 13. In this manner there is obtained roughly the same number of doublets per wavelength along the transmission line of the mean operating frequency for those doublets in each group.

Reverting for a moment to the graphs of Fig. 2, it will be evident that each group of collector doublets of a particular length will respond most efficiently to its corresponding band of frequencies, so that the combination of two or more of such groups, as represented by curves a, b and c, will give the result of high response for a wider frequency band.

Figs. 3a, 3b and 3c employ this principle and give the result of high response for a wider frequency band, as shown in the two curves a' and b' of Fig. 4, which represent respectively the arrangements of Figs. 3a and 3b. The use of a tapered array such as shown in Fig. 3c results in a more uniform response over the desired frequency spectrum.

The capacitors through which the doublets of Figs. 3a, 3b, 3c and 3d are coupled to line TL need not be all of equal capacitance but rather the capacitance should be properly proportioned for each length of doublet to give optimum transfer of voltage to the line TL without imposing adverse loading. The method of selecting the desired value of capacitance is well known in the art.

It is to be distinctly understood that the present invention is not limited to the precise arrangements shown and described since various modifications may be made without departing from the spirit and scope of the invention. It should also be understood that although the invention has been described particularly with reference to a receiving system, it is not limited thereto since the antenna may equally well be used for transmitting purposes. Although the doublets have been shown capacitively coupled to the transmission line TL, it should be understood that the "fishbone" type of array is not limited to such manner of coupling, since the doublets may, if desired, be alternatively connected either resistively or directly to the line TL in the same manner as described in United States Patent No. 1,841,402, supra, and the present invention is applicable to any of these or other types of "fishbone" antennae wherein any desired type of coupling is used between doublets and line.

What is claimed is:

1. A directive receiving antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of transverse relatively closely spaced aerial elements of different lengths loosely coupled to said line for enabling communication with waves over a relatively wide frequency band, said antenna being aperiodic for waves of all frequencies in said band.

2. A directive receiving antenna capable of receiving a wide band of frequencies comprising a straight two wire transmission line, a plurality of relatively closely spaced doublets of different lengths externally and loosely coupled to said line transversely, each doublet having two arms which are coupled to different wires of said line, and high frequency apparatus coupled to one end of said line, said antenna being aperiodic for waves of all frequencies in said band.

3. A directive receiving antenna capable of receiving a wide band of frequencies comprising a two wire transmission line, a plurality of doublets of different lengths externally coupled to said line transversely, each doublet having two arms which are coupled to different wires of said line, high frequency apparatus coupled to one end of said line, and a resistance substantially equal to the surge impedance of said line as loaded by said doublets coupled to the other end thereof, said doublets having lengths which decrease from the end at which said resistance is located toward said high frequency apparatus, said antenna being aperiodic for waves of all frequencies in said band.

4. A directive antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of transverse aerial elements of different lengths coupled to said line for enabling communication with waves over a relatively wide frequency band, each of said aerial elements comprising a pair of arms capacitively coupled externally to said line, there being a group of aerial elements for each different length, said antenna being aperiodic for waves of all frequencies in said band.

5. A directive antenna for communication over a band of frequencies comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of relatively closely spaced aerial elements continuously decreasing in length toward said high frequency apparatus, said elements being loosely coupled to said line, said antenna being aperiodic for waves of all frequencies in said band.

6. A directive receiving antenna capable of receiving a wide band of frequencies comprising a relatively closely spaced straight two wire transmission line, a plurality of energy pick-up doublets coupled transversely and externally to said line, each doublet having two arms which are coupled capacitively to different wires of said line, high frequency apparatus coupled to one end of said line and a damping resistance coupled to the other end of said line, said doublets being divided into groups having different lengths of conductors, said antenna being aperiodic for waves of all frequencies in said band.

7. A directive receiving antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of aerial elements, all of different lengths, continuously tapering in length from one end of said antenna to the other and coupled capacitively to said line, the longest aerial element being located farthest from said high frequency apparatus, said antenna being aperiodic over a wide band of frequencies.

8. A directive antenna comprising a straight transmission line, high frequency apparatus coupled to said line, and a plurality of transverse relatively closely spaced aerial elements of different lengths loosely coupled to said line for enabling communication with waves over a relatively wide frequency band, said antenna being aperiodic for waves of all frequencies in said band.

9. A directive antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of relatively closely spaced aerial elements of different lengths coupled

to said line through limiting impedances for enabling communication with waves over a relatively wide frequency band, said antenna being aperiodic for waves of all frequencies in said band.

10. A directive antenna comprising a transmission line, high frequency translating apparatus coupled to said line at one end, and three groups of transverse aerial elements of different lengths coupled to said line along the length thereof for enabling communication with waves over a relatively wide frequency band, the aerial elements in each group being of the same length, each of said aerial elements comprising a doublet having a pair of arms capacitively coupled externally to said line, said doublets increasing in size from the end of the line to which the translating apparatus is coupled, said antenna being aperiodic for waves of all frequencies in said band.

11. A directive antenna comprising a transmission line, high frequency apparatus coupled to said line, and a plurality of groups of aerial elements of different lengths coupled to said line along the length thereof, the spacings between adjacent elements for the longer elements being greater than for the shorter elements, said antenna being aperiodic over a wide band of frequencies.

MARTIN KATZIN.

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