CHECKING OF « DECCA » PATTERN OF FRENCH CHAIN ON CHART No. 3033 ter, FROM LORIENT TO THE GIRONDE

by H.P.

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The various observations and measurements described below were carried out from 19 th June to 10 th July 1954 on board the Coast Guard Vessel « Carabinier », equipped with a Decca navigational receiver Mark V.

The purpose of this operation was to determine, at the limit of sight from land at predetermined points, distributed along various coastal lanes from Lorient to the mouth of the Gironde, the mean value of corrections to be applied to Decometer readings on the French Decca Chain, as well as the mean uncertainty that should be expected from these corrected readings; and thus enable in so far as possible the maritime use of this chain, which was primarily set up to meet the needs of aerial navigation.

The method adopted consisted in making three simultaneous observations, at two minute intervals, with the hydrographic circle at each predetermined point, the ship having proceeded along a track adjacent to the direction of a hyperbola at a speed of about five knots. The Decometer readings were taken at the same time.

These observations were carried out during the day-time, except during the periods preceding or following sunrise or sunset. Zero control of the Decometers was carried out every hour, and signal strength measurements were checked regularly.

Special observations of stability at night and of base line control were carried out separately, in order that several useful indications regarding the setting and stability of the patterns might be obtained. Results are described in appropriate sections.

The method adopted for analysis of the observations was inspired by the tested procedures developed by H.M.S. « Fleetwood » of the British Admiralty, in a similar observation effected along the coasts of Cornwall and France on the British South-West Decca chain.

The positions obtained by the observation of angles were plotted on charts on the mean scale of 1 : 120 000, Nos. 5405, 5439, 150 G, 5164 and 4872, where hyperbolae of the pattern were transferred point by point. The Decca coordinates,

thus derived from the transferred lattices, were compared with the Decometer readings to obtain the corrections. Each correction was thus derived from three separate stations.

A preliminary study of the chart and of the path of the hyperbolae then enabled all the positions and corresponding corrections to be grouped into sets belonging to similar zones and radio paths. Some positions in which obvious and very localized anomalies could appear *a priori*, owing to the proximity or direction of the coast or to the presence of islands, were eliminated.

The mean correction was computed for each group as well as the error of mean square or « standard deviation », from which the radial dispersion to be adopted for the group was deduced. The control positions were numbered from 1 to 62 between Lorient and the mouth of the Gironde. These numbers will be mentioned on Chart No. 3033 overprinted, in three colours, with the three Red, Green and Purple Decca patterns. An annexed table issued with the chart and a Notice to Mariners will supply the corrections relating to each position as well as the degree of reliability to be given by the navigator, in the form of the value of the radius of uncertainty.

This type of information supplying the individual correction actually observed at each point appeared preferable to the system used on existing Decca charts of British origin, which consists in only supplying the mean corrections for a whole zone or a set of positions in an annexed table. Owing to the rapid variation of these corrections over an extremely short distance, resulting from the proximity of the very irregular coast line, and from navigational requirements through islands or at the entrance of bays along the Atlantic coast, only individual corrections observed at a given point could be relied upon.

Only coastal navigation was checked in sight of land.

In addition to the fact that accurate fixing off shore is a less vital navigational need, checks carried out without visual landmarks would have required a considerable number of observations as well as a conventional process of estimation and reduction which would ultimately have been unreliable.

It is moreover recognized that corrections become stable along an hyperbola in a direction away from the coast and that their values may be derived from those observed near the land.

VALUE OF THE DECCA PATTERN IN THE ZONE COVERED BY CHART No. 3033

On an average, observed corrections are relatively large owing to the distance of the transmitting stations; the extensive wavepath over land; operations carried out at the limit of, or beyond the distance of 240 miles conventionally accepted for the maritime use of Decca; and finally to the residual uncertainty — (no systematic investigation has been carried out to date) — regarding the conformity of propagation speeds adopted for the computation of the grid. These speeds were derived according to the method of Norton and Bremmer by dividing the paths into sections located over ground of constant conductivity.

In the five zones of the chart corresponding to groups of points, the approximate distances to the stations are the following :

	Master	Red	Green	Purple
	km.	km.	km.	km.
Gr. 1. — From Lorient to Belle-Ile	450	310	604	490
Gr. 2. — Approaches to Belle-Ile	392	252	544	428
Gr. 3. — From Belle-Ile to Ile d'Yeu	370	252	532	392
Gr. 4 & 5. — From Ile d'Yeu to Ile de Ré	332	232	492	336
Gr. 6. — From Ile de Ré to Graves	308	248	480	296

It will be seen later on that the uncertainties discovered are closely related to these distances.

The directions of the Red and Purple hyperbolae are relatively close to one another and close to parallels. As regards the Green pattern whose direction is likewise similar, the hyperbolae diverge to a large extent from North to South on the chart as far as the baseline which passes North of the estuary of the Gironde :

ZONE	Approximate Direction of Hyperbolae			Angle of Intersection
	Red	Green	Purple	Red-Purple
Lorient to Belle-Ile	276°	278°	292°	16°
Loire South Channel	273°	276°	291°	18°
Ile d'Yeu	264°	270°	284°	20°
Oleron	248°	259°	275°	27°
Gironde West Channel	240°	254°	270°	30°

To sum up, both the Red and Purple patterns may locate the navigator's *latitude;* the Green pattern, which is too near the base line, only provides a rough approximation.

The theoretical accurate nautical contours established for various seassons of the year, and for day and for night, lead to expectancy, in the case of 95% of daylight observations, of an optimum uncertainty of one-quarter mile along the shore as far as Ile de Ré, from one-quart or to one-half mile between Ile de Ré and Belle-Ile, and up to one-half mile towards the West meridian of the chart. Although these estimations concern the overall accuracies of the fix, it will be seen that results observed regarding the uncertainties of the loci, valid for the same periods, are slightly higher than these values.

PERMANENT CORRECTIONS

Table I shows these corrections in hundredths of a lane, for each numbered position whose geographical coordinates appear opposite.

Some of the corrections are subject to considerable anomalies as regards points located in channels and near islands; such as corrections for the following points :

— Nos. 1, 2, 3, 4 Lorient Channel;

— Nos. 15, 16, 17 Canal of Belle-Ile;

— Nos. 22, 23 Loire South Channel;

— Nos. 18, 19, 20 Entrance to Bay of Quiberon,

or when the direction of master-slave propagation is tangent to a coast in the vicinity, such as the following points :

— No. 6 tangent to Pointe du Croisic;

— No. 13 where Purple is tangent to Saint-Gildas;

— No. 21 where Red is tangent to Saint-Gildas.

Finally, a zone in the vicinity of the mouth of the Gironde, off La Coubre, containing positions Nos. 55, 56, 57, 60 and 61, shows large anomalies which have placed them beyond the scope of dispersion analysis. It is possible that these disturbances may be compared with those which were identified as causing the deviations of the La Palmyre radio-range operating on a frequency of 300 Kc.

The corrections observed on the basis of these positions are shown in the table and are marked « D », which means that the anomalies detected by means of these observations are subject to caution and that every opportunity should be taken to correct them. Finally, positions Nos. 28 and 29 are shown as uncorrected, as it was impossible to base these corrections on valid observations, since a single landmark, or two at the most, could be reliably observed.

RADII OF UNCERTAINTY

In order to meet test conditions, the same Table includes the mean radius of linear uncertainty to be assigned to positions obtained by means of Decca readings after correction, in 95% of the cases. Computations which enable these results to be reached do not appear in the present report but are summarized in Table II. These radii of uncertainty have been obtained by computing, as regards certain sets of observations from which too obviously local anomalies have been eliminated, the mean of observed corrections : $\frac{\Sigma c}{n}$. By calculating the deviation from the mean of each correction, squaring the difference : A=(Correction minus mean), obtaining the sum : ΣA^2 and reducing to the error of mean square $\sqrt{\frac{\Sigma A^2}{n-1}}$, we get the value the Decca technicians call « Standard Deviation », which corresponds to the uncertainty in hundredths of a lane in 65% of cases. This uncertainty, multiplied by 1.96 (or by 2) corresponds to the 95% probability level and this is

the value that was adopted in Table I. It is worth noting in this Table that in the case of « Red », the deviation in hundredths of a lane constantly approximates to ± 6 to ± 7 hundredths. In the case of « Green », which varies from one zone to the next by ± 0.8 to ± 3.5 hundredths, the increasing width of the lane nevertheless produces radii of uncertainty retaining the same order, except in the vicinity of the base line where almost absolute uncertainty prevails. Only one considerable set of fixes (17), from Nos. 7 to 24, reveals an extremely slight mean square error of less than 100 meters. These observations, which were carried out in the Belle-Ile area, consistently gave rise to slight uncertainties. It may be that propagation of the « Green » pattern in his area was favoured by a particular consistency of paths and speeds. As regards the « Purple » pattern, scatter remained slight, considering the lane width, and decreased fairly regularly with the distance from the transmitting stations. Inconsistent values observed in he area of La Coubre were eliminated from these computations and were considered as local anomalies.

It may be pointed out that the system of grouping the observations does not appreciably interfere with the final values of the uncertainties, as other systems selected led to similar values.

CROSSING OF GREEN BASE LINE

The standard line-crossing test of the base line extensions was carried out, as regards the Green pattern, on the Master station side on 1st July, 1954, by means of three crossings in a normal direction to the base line from a point A at 11'.8 on a 270° bearing from La Coubre Lighthouse. In this area, which shows appreciable local anomalies as regards the Red and Purple patterns, the Green pattern, according to correction observations, does not appear subject to appreciable disturbances.

The three crossings were made at the average speed of 7.5 knots in a practically normal direction to the base line, between two points A and B appreciably symmetrical to this base line and 5 miles on either side of it, i. e. on the following bearings :

— 1st Crossing : True Course : 175 to 160;

— 2nd Crossing : True Course : 345 to 335;

— 3rd Crossing : True Course : 165 to 160.

Readings were taken every three nautical miles, distances to the base line were adequately determined by careful dead reckoning, and by the bearings obtained at point A of La Coubre, of Cordouan and buoy BXA, whose position had previously been checked and corrected.

These two factors, i.e. readings in hundredths of the Green pattern and distances in kilometres to the base line, enabled plotting the three observed curves in Plate III relative to the three crossings.

Moreover, by using the theoretical propagation speed of 299,050 kilometres per second, which according to Memo-Plan No. 152 of the Decca Company had

TABLE I

Chart No. 3033 *ter* (Decca)

Mean Permanent Corrections applicable to Decometer Readings during Summer Daylight

Numbers of Positions	Latitude N	Longitude W (Gr.)	Corrections in hundredths of a lane			Radius of Uncertainty Average in Metres at 95 % Probability Level			Observations
			Red	Green	Purple	Red	Green	Purple	
1	47° 39',9	3° 22',0	— 2	— 6	+ 6				
2	47° 36',7	3° 21',3	+ 2	— 12	+ 24				
3	47° 34',7	3° 14',6	— 1	— 11	+ 18				
4	47° 32',5	3° 20',7	— 12	— 15	+ 28				
5	47° 30',1	3° 11',0	— 18	— 20	+ 28	450 m.	600 m.	400 m.	
6	47° 31',3	3° 25',6	— 8	— 5	+ 39				
7	47° 24',3	3° 21',7	— 24	— 25	+ 28				
8	47° 20',4	3° 22',1	— 26	— 28	+ 23				
9	47° 17',0	3° 21',7	— 26	— 29	+ 12				
10	47° 12',5	3° 20',1	— 17	— 28	+ 13				
11	47° 12',8	3° 07',2	— 13	— 27	+ 13				
12	47° 12',6	2° 50',4	— 12	— 26	+ 30				
13	47° 12',3	2° 33',9	— 19	— 26	+ 11				
14	47° 14',6	2° 43',6	— 11	— 28	+ 10				
15	47° 19',10	3° 03',4	— 19	— 22	+ 25	400 m.	200 m.	360 m.	
16	47° 23',8	3° 03',5	— 21	— 19	+ 49				
17	47° 25',4	3° 09',1	— 22	— 18	+ 48				
18	47° 18',6	2° 44',3	— 3	— 21	+ 10				
19	47° 23',4	2° 46',7	— 13	— 13	+ 47				
20	47° 28',4	2° 55',6	— 14	— 16	+ 43				
21	47° 09',6	2° 36',6	— 13	— 28	+ 20				
22	47° 08',1	2° 20',1	— 9	— 25	+ 15				
23	47° 11',3	2° 17',0	— 20	— 27	+ 28				
24	47° 07',5	2° 37',4	— 6	— 27	+ 25				
25	47° 07',2	2° 43',2	— 16	— 33	+ 32				

26	47° 04',0	2° 32',7	— 13	— 32	+ 37			
27	47° 03',2	2° 25',4	— 18	— 32	+ 33			
28	47° 03',1	2° 38',5						
29	47° 00',7	2° 42',4						
30	46° 58',6	2° 34',3	— 20	— 30	+ 28			
31	46° 54',6	2° 30',5	— 39	— 30	+ 29			
32	46° 50',6	2° 26',2	— 26	— 27	+ 18			
33	46° 47',8	2° 24',6	— 8	— 20	— 5	350 m.	600 m.	330 m.
34	46° 45',6	2° 35',11	— 23	— 29	+ 13			
35	46° 44',3	2° 26',7	— 23	— 26	+ 14			
36	46° 38',8	2° 30',6	— 24	— 27	+ 22			
37	46° 39',10	2° 19',3	— 13	— 22	+ 16			
38	46° 38',3	2° 10',2	— 14	— 22	+ 15			
39	46° 19',3	2° 02',2	— 6	— 14	+ 18			
40	46° 31',7	2° 02',9	0	— 21	+ 7			
41	46° 26',7	1° 55',4	— 3	— 18	+ 9			
42	46° 19',3	1° 50',0	+ 9	— 23	+ 5			
43	46° 19',7	1° 40',2	— 3	— 24	+ 20	290 m.	800 m.	200 m.
44	46° 15',7	1° 42',1	— 6	— 23	+ 23			
45	46° 10',7	1° 42',1	— 16	— 23	+ 21			
46	46° 11',8	1° 37',8	— 14	— 23	+ 23			
47	46° 09',7	1° 35',7	— 16	— 20	+ 4			
48	46° 07',3	1° 34',2	— 24	— 21	— 3			
49	46° 06',5	1° 25',2	— 20	— 20	— 8			
50	46° 05',5	1° 16',6	— 10	— 17	— 2			
51	46° 02',6	1° 38',10	— 26	— 26	+ 14			
52	45° 57',10	1° 29',6	— 25	— 13	+ 2			
53	45° 52',8	1° 32',6	— 18	0	— 5	200 m.	4.800 m.	250 m.
54	45° 52',2	1° 23',10	— 16	+ 18	— 7			
55	45° 47',8	1° 30',3	— 23	0	+ 16			
56	45° 43',10	1° 25',5	— 55	— 6	+ 35	D		
57	45° 40',1	1° 33',3	— 5	— 10	— 3	D		
58	45° 39',10	1° 27',1	— 25	— 13	— 6	D		
59	45° 39',8	1° 21',2	— 15	— 18	+ 4			
60	45° 37',6	1° 28',4	+ 2	— 18	— 22	D		
61	45° 34',3	1° 26',6	— 10	— 21	— 15	D		
62	45° 33',8	1° 20',5	— 31	— 22	+ 7			

D. — Corrections so marked are subject to caution. Pas d'observation = 28, 29 } No observation.

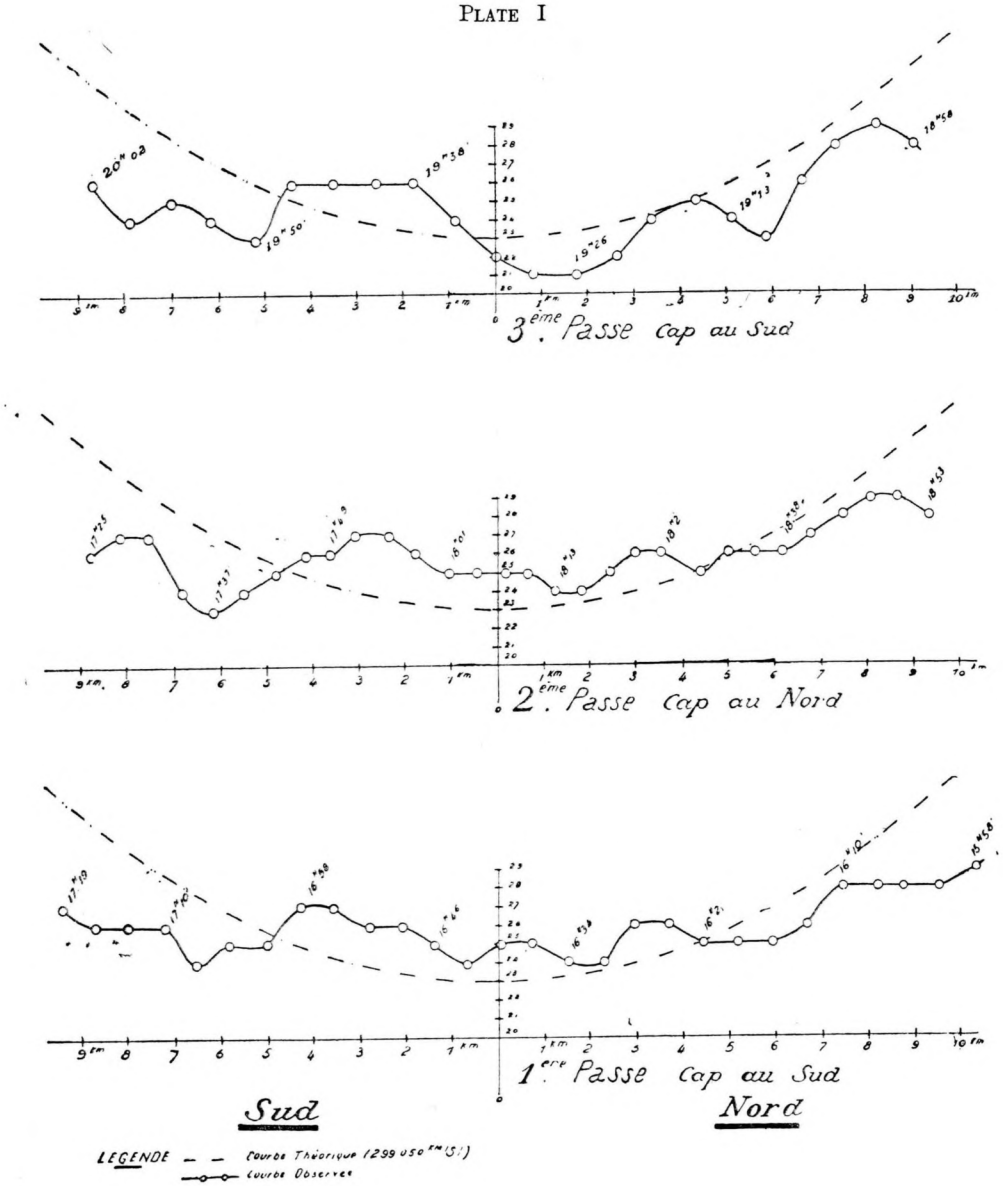
TABLE II

Chart No. 3033 (Decca)

Observations from Carabinier, *22nd June to 2nd July* 1954
Standard Deviation during Daylight

		RED	GREEN	PURPLE
Group 1 — Belle-Ile to Lorient (1 to 6)	Number of observations ..	16	12	15
	Average of corrections ..	— 5	— 14,5	± 27
	Standard deviation	+ 5	± 3,5	± 5,5
	Average lane width	4 300 m	8 600 m	2 400 m
	Mean linear uncertainty ..	± 215 m	± 300 m	± 195 m
Group 2 — Approaches to Belle-Ile (7 to 24)	Number of observations ..	27	27	27
	Average of corrections ..	— 17,7	— 27	± 18,2
	Standard deviation	± 6	± 1	± 8
	Average lane width	3 300 m	8 700 m	2 200 m
	Mean linear uncertainty ..	± 200 m	± 90 m	± 180 m
Group 3 — Belle-Ile to Ile d'Yeu (26 to 38)	Number of observations ..	28	30	30
	Average of corrections ..	— 22	— 27,1	+ 22,3
	Standard deviation	± 6	± 3,3	± 8,2
	Average lane width	2 800 m	8 800 m	2 000 m
	Mean linear uncertainty ..	± 168 m	± 290 m	± 164 m
Group 4 — Ile d'Yeu to Ile de Ré (29 to 42)	Number of observations ..	12	12	12
	Average of corrections ..	+ 3,2	— 19,1	+ 9,6
	Standard deviation	± 7	± 3,5	± 5
	Average lane width	2 060 m	11 700 m	1 950 m
	Mean linear uncertainty ..	± 144 m	± 409 m	± 98 m
Group 5 — Ile d'Yeu to Ile de Ré (cont.) (43 to 46)	Number of observations ..	12	12	12
	Average of corrections ..	— 10	— 23	+ 21,5
	Standard deviation	± 6	± 0,8	± 2
	Average lane width	2 100 m	14 900 m	1 650 m
	Mean linear uncertainty ..	± 126 m	± 119,2	± 33 m
Group 6 — Ile de Ré to Pointe de Graves (47 to 62)	Number of observations ..	33	27	30
	Average of corrections ..	— 20,4	— 16,3	— 1,5
	Standard deviation	± 6	± 5	± 8,3
	Average lane width	1 600 m	48 000 m	1 500 m
	Mean linear uncertainty ..	± 96 m	± 2 400 m	± 125 m

PLATE I



Crossing of Green base line extension (Master side)

to be used as a basis for plotting the lattices, the theoretical « pseudo »-parabola was constructed; its equation is :

$$Y = \frac{fc \cdot b \quad x^2}{2\,ca\,(b+a)},$$

in which :

— Y is the difference in hundredths of Green lanewidths at each point with reference to the base line minimum (in principle, A 30);

— fc is the Green comparison frequency : 256.635 kc/s.;

— b is the Green base line : 179.467 km.;

— a is the distance of each crossing to the Master station, the track being normal to the base line. This appreciably constant distance is equivalent to 335.21 km. (It should be pointed out that errors b, a and x only involve second order errors for values of Y);

— x finally is the distance of the point concerned to the base line expressed in kilometres.

We thus get approximately :

$$Y = L = \frac{4{,}463}{10^4} x^2.$$

When slid along each observed curve, this theoretical parabola more or less approximately fits these curves, particularly curves 1 and 2, observed in broad daylight, leaving a difference of 23 hundredths of a lane, which is the approximate minimum when crossing the base line.

This discrepancy corresponds not only to this minimum but also to the mean permanent corrections observed in the Green pattern of the zone as a whole.

The result would be that the actual base line would read A 30.23 instead of A 30, i.e. that the base line would comprise, if *adjustment at the Green slave station were taken as a reference*, 307.80 lanes instead of 308.025, which is the theoretical figure. This means that the actual overall propagation speed, for the Green pattern, would be :

$$\frac{nc}{f} = b = \frac{307.80\ c}{256.635} = 179{,}467 \text{ km.},$$

whence we get : $c = 299{,}260$ km/s approximately instead of 299,050 km/s. Results are summarized in the table below.

This table is a special analysis of observations carried out by the « Carabinier », in which the following is assumed :

(1) That the theoretical residue of 0.025 of a lane at the slave end of the Green base line is actually observed, resulting in a change in the number of Green lanes on the base line between two readings : A 30.23 on the Master side and H 15.025 on the slave side.

(2) That this change is exclusively due to a difference in speed of actual propagation in relation to the empirical speed selected for the computations.

As regards the first assumption, only a check of the Green slave station reading will enable its confirmation.

As regards the second assumption, its should be stressed that, if the various types of ground conductivity along the path may alone justify such a difference in speed, the decrease in the number of lanes may likewise be caused by a difference in the actual path of the signal between the Master and Green slave. This distance, theoretically reckoned on a geodetic are joining the Master and the slave, may be

appreciably modified by the shape of the path, which by following the ground relief, is necessarily subject, at a low altitude, to lateral and above all to vertical deviations.

Pattern	Base line extension	ESTIMATED			OBSERVED		
		Estimated Propagation Speed	Number of Lanes	Readings Estimated	Readings Observed	Number of Lanes	Observed Propagation Speed
Green	Master end	299,050	308.025	A 30,00	A 30,22	307,80	299,260 km/s
	Slave end			H 15.025	H 15.03		

A more approximate distance should, we believe, allow for actual paths travelled along slopes.

An examination of the correction table leads to the belief that similar corrections might be worked out later by crossings of the Red base line in the Channel and the Purple base line in the Mediterranean, north of Ivice.

Finally, as regards the Green pattern, if later and generalized observations were to confirm the size of the corrections that have already been obtained, a change in transmission adjustment could rectify the setting of the pattern and bring it closer to its charted position.

IDENTIFICATION, TORQUE UPON RECEPTION AND ZERO STABILITY

During daylight, the indentification system operated regularly in a normal, correct manner. The dials lighted up in the proper order except for slight irregularities when crossing squall areas.

When the main radio receiver on board was started up, consuming 135 watts and operating on 2589 kc., the rotary converter unit likewise being used for the Decca equipment, the identification system showed upon several occasions a backward skip of 1 hyperbola, almost exclusively located in the Red pattern.

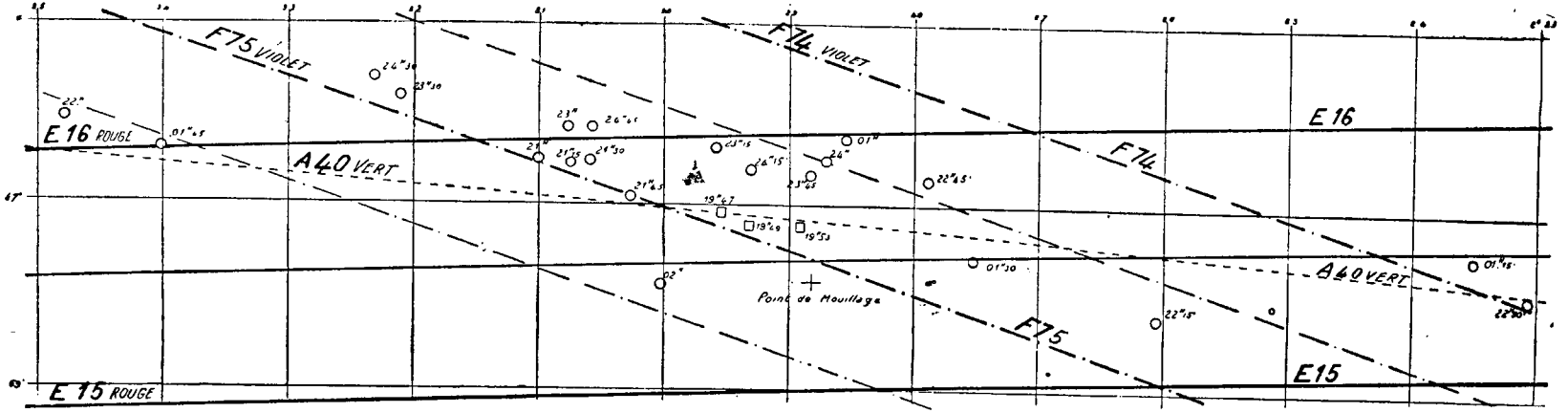
On the other hand, torque which was regularly observed by working the « Test » button, was normal and amounted, on the average, to twelve divisions on Red, ten on Green and fifteen on Purple.

The REFS were checked every hour on the hour, and corrections did not exceed $\pm$ two divisions by daylight.

NIGHT OBSERVATIONS

With the limited purpose of obtaining only indications as regards pattern stability, methodical observations were carried out by the « Carabinier » in two anchored positions : from 23 rd to 24 th June, 1954, at the entrance of the Loire South Channel, 239° and 10,900 metres from Pilier Lighthouse (Position « a »),

PLATE II



Night observations at anchor in the Loire South Channel

Anchorage point : L = 46°59'35'' N, Gr. = 2°28'50'' O (Gr.)

Decca co-ordinates by day : Red : E 15.33, Green : A 39.93. Purple : F 75.27

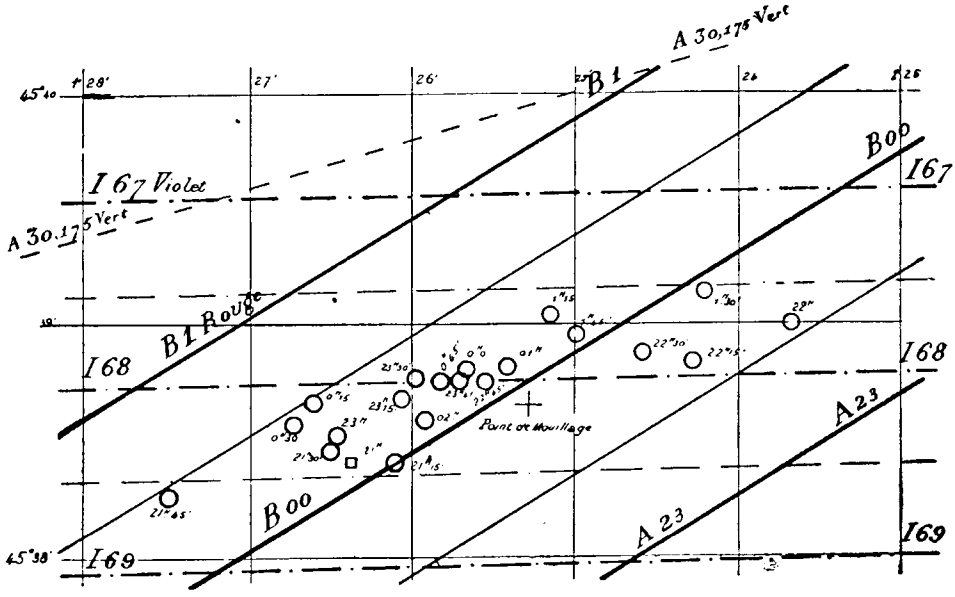
Decca readings by day : Red : E 15.69, Green : A 40.28, Purple : F 74.94

\+ Position observed by daylight ; ○ Night readings; □ Daylight readings

Scale: 1:60,000

and from 1st to 2nd July, 1954, a the entrance of the Gironde West Channel (Position « b ») : Lat. 45° 38' 40" N and Long. 01° 23' 18" W. In both cases, the position, which was determined by circle observations by day, was corrected for the swing of the ship, and readings were obtained, both by day and by night, the latter every fifteen minutes between 21.00 and 02.00 hours. As in the case of all previous observations, careful record was made of the state of the weather.

PLATE III



Night observations at anchor in the Gironde West Channel

Anchorage point: L = 45°38'40" N, Gr. = 1°23'18" O (Gr.)
Decca co-ordinates by day: Red: A 23.92, Green: A 30.048, Purple: I 68.15

+ Position observed by day daylight; ○ Night readings; □ Daylight readings
Scale: 1:77,000

(a) *Identification.*

Numerous lane skips were recorded. These occurred more frequently at the entrance of the Loire South Channel, than in the Gironde area, and in some cases, faulty operation of the Lane Identification system was noted.

Incidents of lane skipping, as well as identification lapses, have been summarized in the table on page...

It is clear from these results that the identification system is not reliable during a normal night in the zone of coverage of Chart No. 3033, and particulary around Position « a » in the Loire South Channel.

It was possible to foresee this conclusion, taking into account the distances from these zones to the transmitters, ranging from 480 to 200 n. m., which are all greater than the values normally accepted for the reliable use of the identification system at ground level.

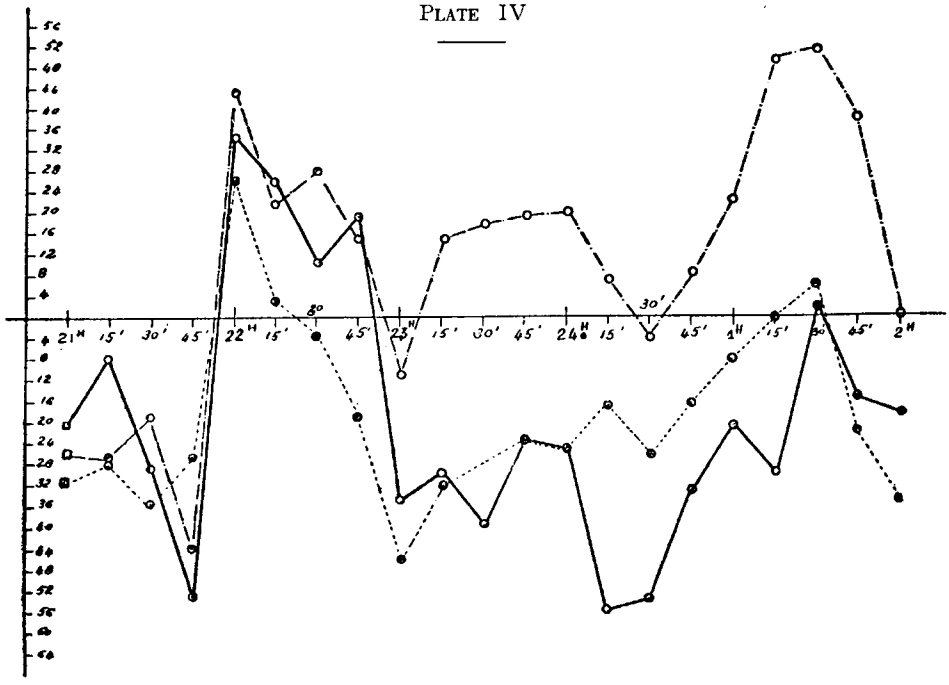
Position « a » : *Loire South Channel* (night of 23rd/24th June, 1954)

TIMES	LANE SKIPPING			NO ORIENTATION
	Red	Green	Purple	
21 h 50	0	— 2	— 4	
22 h 00	0	0	— 3	
22 h 10	+ 4	— 1	— 3	
22 h 20			— 3	
22 h 40	+ 4	— 4	+ 2	
22 h 55	+ 1	0	+ 2	
23 h 05	+ 4	0	— 3	
23 h 20	+ 4	+ 3	+ 6	
23 h 55	0	+ 7		Purple
0 h 20	+ 4	+ 3		Purple
0 h 35	+ 3	—10	+ 6	
0 h 50	0	— 8	+ 2	
1 h 05	0	— 2	+ 5	Red
1 h 15	0	— 4		Purple
1 h 30	+ 4	— 1	+ 5	
1 h 50	0		—11	Green

Position « b » : *Gironde West Channel* (night of 1st/2nd July, 1954)

TIMES	LANE SKIPPING			NO ORIENTATION
	Red	Green	Purple	
21 h 45	0	0		Purple
22 h 00	— 3	— 5	— 5	
22 h 15	0	— 1	+ 1	
22 h 30	— 1		0	Green
22 h 45	— 1	+ 1	+ 1	Green
23 h 00			0	Red-Green
23 h 15	0	+ 2	0	
23 h 30	0			Green-Purple
23 h 45	0		0	Green
...	0	— 2	+ 5	

PLATE IV



Stability curves at night, position (*b*) Gironde West Channel

Geographical coordinates: L = 45°38'40" N, Gr. = 1°23'18" O (Gr.)
Decca coordinates: Red: A 23.92, Green: A 30.05, Purple: I 68.15

□ Decca readings by day; ○ Decca readings by night
———— Red; - - - - - - - Green; —.—.—.—. Purple

These limited observations are nevertheless adequate in order to check this result; they only apply to two non-consecutive nights which were absolutely normal, i.e. weather conditions were average, wind steady, cloudiness three-quarters and visibility 10 to 15.

(b) *Analysis of night readings.*

Decometer readings recorded every fifteen minutes at anchorage points « a » and « b » from 21.00 to 02.00 hours were analysed along the lines used for day observations by calculating standard deviation at night and average dispersion at the 95% probability level.

These results are illustrated by the three stability curves which, at positions « *a* » and « *b* », show oscillations in the three patterns an Plate IV.

The factors deriving from the first analysis are summarized in the table below :

		RED	GREEN	PURPLE
Anchorage Position « *a* » (night of 23rd/24th June, from 21.00 to 02.00 hours)	Number of observations ..	21	21	20
	Average of night corrections	— 43	— 46	+ 37
	Average of daylight corrections	— 32	— 34	+ 35
	Average lane width	± 31	± 18,7	
	Standard deviation	2 600 m	8 800 m	
	Mean linear uncertainty at the 95% probability level	± 1 083 m	± 3 270 m	± 1 610 m
Anchorage Position « *b* » (night of 1st/2nd July, from 21.00 to 02.00 hours)	Number of observations ..	21	21	21
	Average of night corrections	— 20	— 19	+ 11
	Average of daylight corrections	— 21	— 31	— 26
	Average lane width	± 25,3	± 13,6	± 25,7
	Standard deviation	1 600 m	48 000 m	1 500 m
	Mean linear uncertainty at the 95% probability level	± 810 m	± 13 000 m	± 770 m

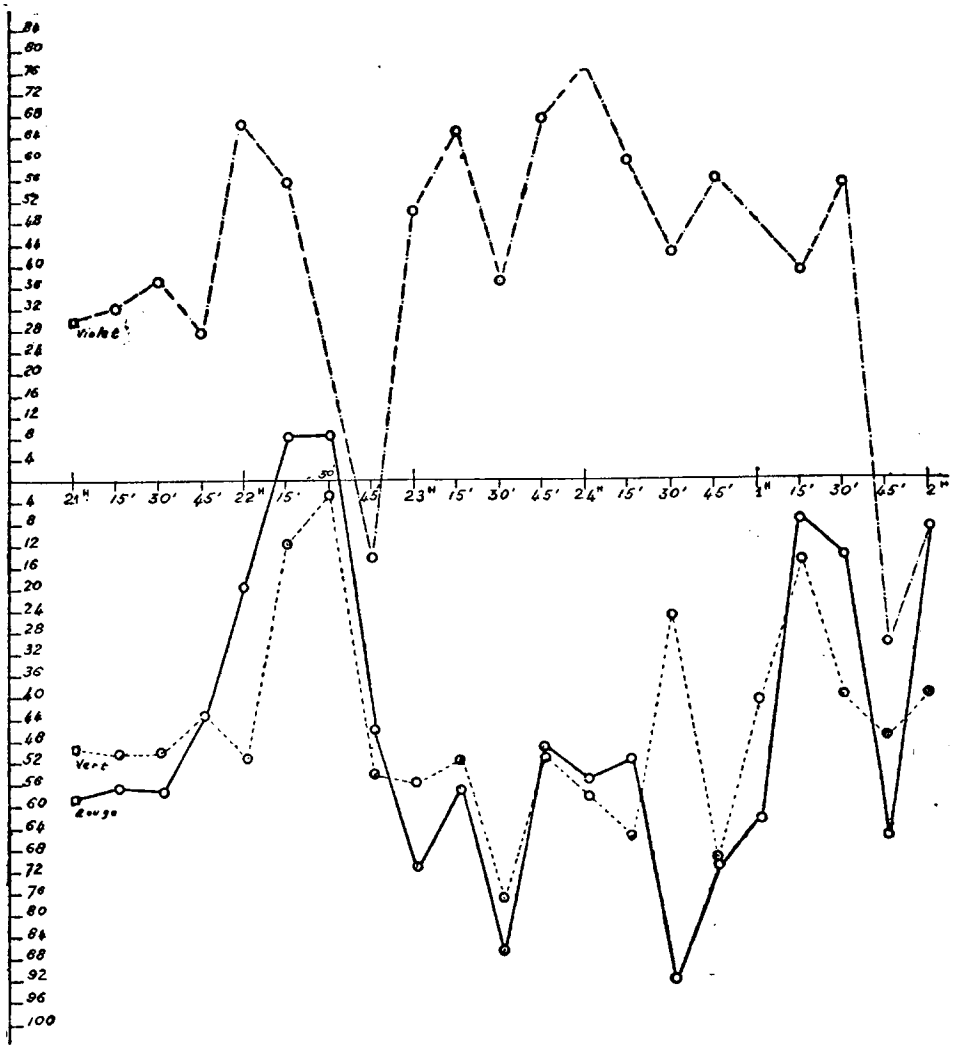
These observations should be, of course, repeated and increased, but the consistency shown by the analysis proves that in spite of their small number they supply values that may be adopted as a first approximation. In particular, the radii of dispersion at night at the 95% level, except for anomalies of propagation, may be accepted for ordinary navigation purposes in the Green and Red patterns, retaining a value, even in the north zone, of less than ± 1 n.m.

As regards night corrections, the same caution should be exercised in the mouth of the Gironde area as for daylight corrections owing to the possibility of local disturbances which, in the case of Purple, would here appear in the form of a sizable difference between the daylight corrections and the night corrections.

NIGHT STABILITY CURVES

There is a remarkable degree of correlation between the night stability curves in Plates IV and V. With times shown as abscissae, the ordinates are the

PLATE V



Night stability curves, Station (*a*) Loire South Channel

Geographical coordinates: L = 46°59'35" N, Gr. = 2°28'50" O (Gr.)
Decca coordinates: Red: E 15.33, Green: A 39.93, Purple: F 75.27

□ Decca readings by day; ○ Decca readings by night
———— Red; - - - - - - - Green; —.—.—.—. Purple.

corrections that should be applied to the Decca coordinates of the exact position which was obtained during daylight and adjusted for the swing of the ship during the night.

Oscillations in the three patterns are similar and almost parallel, except in the case of Purple, which, at Stations « *a* » and « *b* », shows a specific disturbance between 22.45 and 01.15 hours at Station « *a* », and from 23.00 to 00.15 hours at Station « *b* ». This deviation appears in the same direction in both cases and amplitudes are in ratio to the value of the common oscillation. It is probable that a typical effect of superposition of the reflected wave on the Purple signals is involved.

The similarity of these effects at approximately similar times on the Purple signals only during the two nights of 23rd/24th June and 1st/2nd July is particularly remarkable.

Local meteorological conditions observed were such that these two series of observations can be regarded as standard.

CONCLUSIONS

These figures enable certain deductions to be made regarding the stability and set of the chain. If recourse is had to the factors used in the construction of the lattice, various assumptions may be made regarding the paths of the signals, the nature and conductivity of the ground over which they pass, or the speed of propagation.

With regard to use in air navigation, it is possible that the size of corrections would be reduced and become more uniform with height.

In conclusion, this checking operation has shown that in the coastal navigation area covered by Chart No. 3033, the Red and Purple patterns could be used in summer daylight with an accuracy at least equivalent to the accuracy of a position fixed in sight of land. In spite of its lesser sensitivity, the Green pattern is of definite use owing to its slight vulnerability to local influences. At night, except for temporary propagation anomalies, all three patterns give evidence of an accuracy approaching astronomical accuracy.